EFFECT OF SUPER SLURPER (HYDROLIZED STARCH POLY-
ACRYLONITRILE GRAFT COPOLYMER) ON SOIL
CRUST STRENGTH, SOIL WATER RETEN-
TION, AND SOIL WATER INFIL-
TRATION RATE

By

PARICHEHR HEMYARI

Bachelor of Science

Pahlavi University

Shiraz, Iran

1977

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
May, 1980

EFFECT OF SUPER SLURPER (HYDROLIZED STARCH POLY-
ACRYLONITRILE GRAFT COPOLYMER) ON SOIL
CRUST STRENGTH, SOIL WATER RETEN-
TION, AND SOIL WATER INFIL-
TRATION RATE

Thesis Approved:

D L Nofziger
Thesis Adviser

John F Stone

Wayne W. Huffine

L Allen Hurlburt

Norman N Durham
Dean of Graduate College

ACKNOWLEDGMENTS

Much appreciation and gratitude is extended to all of those who assisted in this research:

To my thesis adviser, Dr. D. L. Nofziger, to whom I am deeply indebted for his guidance, assistance, and friendship.

To the other members of my committee: Dr. J. F. Stone, Dr. W. W. Huffine, and Dr. T. A. Haliburton, for their suggestions and constructive criticisms.

Finally, my deep and sincere appreciation to my family, especially to my sister Shahla, to whom I owe the greatest gratitude.

This acknowledgment would not be complete without a very special thanks to God our Lord for keeping me in faith and giving me strength throughout my life.

TABLE OF CONTENTS

LIST OF TABLES

Table		Page

LIST OF FIGURES

Figure	Page

CHAPTER I

INTRODUCTION

It is difficult to find a soil that is in perfect physical condition for all possible uses. In the past, man has tilled the soil and added organic residues to improve it for different agricultural uses. More recently, the producers of soil conditioners produce a large number of physically and chemically active materials that are added to the soil for the purpose of improving its physical condition. Soil water and soil aeration are two of the important factors in soil productivity. Water management and conservation are necessary in order to have a stable and efficient agriculture. Soil conditioners may be added to the soil to improve air-water relations. Water deficiency in arid regions is a major problem. Soil conditioners may be used for reducing evaporation and for increasing water content of the soil. In sandy soils, low water holding capacities and high infiltration rates can be major problems in establishing a successful irrigation project. In clayey soils, crust formations sometimes cause problems for seedling emergence. Soil conditioners may be added to the soil to overcome these problems.

The purpose of this study was to investigate the effect of hydrolized starch polyacrylonitrile graft copolymer, commonly called super slurper, on soil crust strength, soil water retention, and soil water infiltration rate. These properties were studied for sandy loam, clay loam, and loamy sand soils.

CHAPTER II

LITERATURE REVIEW

A. Super Slurper

Super slurper which is chemically known as hydrolized starch polyacrylonitrile graft copolymer was developed in the Northern Regional Laboratory, Agricultural Research Service, U. S. Department of Agriculture, Peoria, Illinois. It has been used for research study since late 1975. Super slurper may exist in different forms, including films, powder, thin cushiony mats, or flakes (Shrader and Mostejeran, 1976). It has some interesting and useful properties. It is insoluble in water, it swells very much, and it produces sheets of gel which, when wet, are similar to the dry films, but are 30 times larger in surface area than dry films (Weaver et al., 1974). Three different generations of super slurper with different absorbing abilities were developed at the Northern Laboratory. They are able to absorb 700, 1,000, and 2,000 times their weight of deionized water. The cost of production of each pound of super slurper is 30 cents if each pound of corn starch is eight cents (Shrader and Mostejeran, 1976).

Super slurper has increased water holding capacity of sand. In a greenhouse experiment at Iowa State University, it was observed that mixed sand (fine and coarse) with particle diameters between 0.02 and 2 mm retained 178 grams of water per 1,000 grams of soil while the sand plus 0.2% (by weight) super slurper retained 259 grams of water per 1,000 grams of soil at 0.33 bars suction. Oats died 14 days after seeding in the sand, but after 25 days in sand treated with super slurper. It was also observed that addition of 0.1% super slurper to the sandy soil could prevent wind erosion (Shrader and Mostejeran, 1976).

B. Soil Crust Formation

Petezval and Lutz (1957, p. 485) defined soil surface crust as "a hard layer formed on the soil surface as a result of natural processes, principally the impact of raindrops and drying." The thickness of crusts varies from 0.1 to 5 cm (Evans and Buol, 1968). Tackett and Pearson (1965) observed that water permeability of the soil underlying the crust was five times that of the crust. The bulk density of the crust was greater than the bulk density of soil beneath the crust. It was seen for some crusts that the bulk density of crust was 1.39 g/cc and the bulk density of soil beneath them was 1.19 g/cc (Free, 1952).

Two different groups of factors affect crust formation. The first one is external factors which produce energy, such as impact of raindrops and radiant energy of the sun (Rawitz and Hazan, 1978). Number, size, and velocity of drops determine the impact energy of the raindrops per unit area (Neal and Baver, 1937). Different studies have shown that raindrop impact causes compaction of the soil, breakdown of soil aggregates, deposition of the fine particles at the soil surface, and finally crust formation (Petezval and Lutz, 1957). The second group of factors which affect crust formation is the natural properties of the soil (Rawitz and Haza, 1978). Different soils with various chemical and physical properties have different degrees of natural crusting

(Petezval and Lutz, 1957). Crust formation occurs in most textures of soils except soils of primarily coarse sand with small amounts of silt and clay (Lutz, 1947). Carnes (1934) observed that soils with 40% or more of fine sand are susceptible to crust formation. The tendency for crust formation is increased by dispersing agents, such as sodium (Allison and Moore, 1956; Carnes, 1934).

Different methods have been used for evaluation of soil crust strength. Parker and Taylor (1965) used a penetrometer to measure soil crust strength of six different soils. They observed that seedling emergence decreased in 5 of 6 soils when soil strength increased above three bars. At 18 bars, seedling emergence stopped. Morton and Buchele (1960) evaluated soil crust strength according to emergence energy of plant seedling. They designed a penetrometer that measured emergence energy. They saw that the energy necessary for seedling emergence would increase when crust strength increased. Richards (1953) and Carnes (1934) used modulus of rupture for crust strength measurement. Modulus of rupture seems to be the most reliable method (Petezval and Lutz, 1957). It was observed that as soil crust strength increased, the modulus of rupture also increased. An increase of modulus of rupture from 108 to 273 millibars reduced the seedling emergence of beans from 100 to 0.0% (Richards, 1953). Stauffer (1927) found that the modulus of rupture increased linearly with the clay content of the soil.

In order to solve crust problems, different methods have been used. These include breakdown of crusts by mechanical means (Holder and Brown, 1974), increasing moisture content of soil surface by use of frequent light irrigation (Rawitz and Hazan, 1978), use of plastic cover to reduce water evaporation (Bennett et al., 1964), addition of mulches to the soil surface to protect the soil from the impact of raindrops (Petezval and Lutz, 1957), and addition of synthetic soil conditioners to increase the amount of stable soil aggregates (Allison, 1952; Allison, 1956; Allison and Moore, 1956; and Jamison, 1954). Allison (1952) studied the effect of CRD-186 (Calcium carboxylate polymer) and CRD-189 (sodium salt of hydrolized polyacrylonitrile) on the stability of the soil aggregates. He added these two soil conditioners to the soil which was very susceptible to crust formation. He observed that corn stands were 40% greater in treated soils than in untreated soils. Allison and Moore (1956) considered the effect of VAMA (vinyl acetate-maleic acid copolymer) and HPAN (hydrolized polyacrylonitrile) on modulus of rupture of several alkali soils. The two soil conditioners reduced modulus of rupture. Modulus of rupture decreased from 0.53 to 0.0 bars for San Luis sandy loam by addition of 0.1% (by weight) VAMA or HPAN. It was also observed that modulus of rupture reduced from 3.90 to 2.42 and from 3.90 to 2.70 bars for Billing clay loam by addition of 0.1% (by weight) VAMA and HPAN, respectively. Allison (1956) in another experiment, found that VAMA and HPAN reduced soil crust strength and increased stand and yield of sweet corn. Dement and Martin (1955) investigated the effect of IBMA (copolymer of isobutylene), VAMA (vinyl acetate-maleic acid copolymer), and HPAN (hydrolized polyacrylonitrile) on soil crust formation and seedling emergence. IBMA, VAMA, and HPAN were added to the Miami silt loam at a rate of 42 lbs./acre. IBMA, VAMA, and HPAN reduced crust formation and increased seedling emergence. The amount of stable soil aggregates larger than 0.25 mm in diameter increased. Jamison (1954) observed that modulus of rupture was reduced from 2.45 to 1.20 bars for Hiwassee sandy loam by addition of 0.05% (by weight) VAMA. Addition of dilute phosphoric acid to Portneuf silt loam reduced soil crusting. The amount of stable soil aggregates increased 15 to 60% by addition of 69 Kg/ha phosphorus as dilute phosphoric acid (Robbins and Carter, 1972).

C. Soil Water Retention

The infiltration rate and water retention characteristics of soils are two of the important soil physical properties which give information about water movement in the soil (Cameron, 1978). Soil-water content and soil-water suction are dependent upon each other. The curve which shows the relationship between soil-water content and soil-water suction is called the soil moisture characteristic curve or soil-water retention curve (Childs, 1940). Childs states that the water retention curve gives information about the pore size distribution, just like soil mechanical analysis that gives information about the size of the particles. Shrader and Mostejeran (1976) studied the effect of super slurper on the soil-water content. They found that addition of 0.2% (by weight) super slurper to Nicollet loam and to a sandy soil with particle diameter between 0.02-2 mm increased the water content from 0.22 to 0.24 g/g and from 0.04 to 0.16 g/g, respectively at 0.3 bars suction. At 15 bars suction, water content increased from 0.12 to 0.13 g/g and from 0.02 to 0.04 g/g for Nicollet loam and sandy soil, respectively. Allison (1956) studied the effect of HPAN (hydrolized polyacrylonitrile) and VAMA (vinyl acetate-maleic acid copolymer) on water retention of four different soils. The soils were Pachappa loam, Billings clay loam, Pachappa loam (alkali), and Umapine loam. HPAN and VAMA were used at the rate of 0.1% by weight. Water retention was measured at 0.1, 0.33, 1, and 15 atmospheres suctions. It was observed that water retention increased for the treated alkali Pachappa soil at 0.33, 1, and 15 atmospheres for both HPAN and VAMA; HPAN and VAMA did not have any effect on water retention of non-alkali Pachappa soil. Water retention increased for treated Umapine soil only at 0.1 and 15 atmospheres. Water retention was also increased for treated Billings soil at 0.33 and 15 atmospheres. Kowsar et al. (1969) studied the effect of petroleum mulch on water content of soil. It was observed that addition of petroleum mulch to a bare soil increased water content from 0.17 to 0.32 g/g at 11 bars suction. Bouyoucos (1939) studied the effect of organic matter on water holding capacity of soil. He observed that addition of 12% (by weight) muck to plain field sand, Miami sandy loam, and Aiken clay loam increased the soil water content from 0.09 to 0.24; 0.13 to 0.25, and 0.34 to 0.43 g/g at 0.33 bars, respectively. Peters et al. (1953) investigated the effect of CRD-186 (calcium carboxylate polymer) and CRD-189 (sodium salt of hydrolized polyacrylonitrile) on water content of soil. It was observed that addition of CRD-186 and CRD-189 at a rate of 0.4% (by weight) increased the water content of coarse-textured soil very little.

D. Soil Water Infiltration Rate

Richards (1952, p. 85) defined infiltration rate as "the maximum rate at which a soil, in a given condition, at a given time, can absorb rain." Kostiakov (1932) described infiltration rate by an empirical equation. The equation is

$$I = bT^a$$

where I is infiltration rate (volume of water per unit time per unit area), a and b are parameters that depend on the physical properties of the soil, and T is time. Philip (1957) evaluated Kostiakov's equation and found that as time approached zero, a = 1/2, and b = S, where S is sorptivity. Sorptivity is a physical property of porous media. It is a measure of capillary uptake or release of water. Kostiakov's equation is simple. It fits the experimental data of infiltration moderately well (Philip, 1957). Philip also found another equation by use of Darcy's law and the equation of continuity. Philip's equation was

$$I = ST^{\frac{1}{2}} + (K + S)T + BT^{3/2} + CT^{2} + \ldots\ldots$$

where I is cumulative infiltration, T is time, S is sorptivity, K is hydraulic conductivity, and B and C are functions of water content. Philip (1957) showed that the above equation converged for all except very large times. For small to moderate times, he found the series could be represented by

$$I = ST^{\frac{1}{2}} + AT$$

where I is cumulative infiltration rate, T is time, S is sorptivity, and A is a parameter which depends upon the ability of soil to transmit water.

According to Lewis and Powers (1938) there are two groups of factors that affect infiltration rate. The first one includes those factors that affect infiltration rate at a given time and point. The second group includes factors that affect the average infiltration rate over a large area and considerable amount of time. The first group includes structure, texture, and porosity. The second group includes slope, vegetation, and surface roughness. Hillel (1971) and Israelsen and Hansen (1962) state that the infiltration rate depends on time, initial moisture content, and presence of impermeable layers in the soil profile. Infiltration rate is high at the early stage and decreases as time passes. The infiltration rate decreases as the initial moisture content of the soil increases.

Reitemeier and Christiansen (1946) investigated the influence of organic matter and gypsum on infiltration rate of a soil which was irrigated with water of high sodium content. They found that addition of gypsum into the soil at a rate of 5 tons per acre, or organic matter at the same rate approximately doubled the infiltration rate. Allison (1956) considered the effect of VAMA (vinyl acetate-maleic acid copolymer) and HPAN (hydrolized polyacrylonitrile) on infiltration rate of Pachappa loam. The soil had a high content of exchangeable sodium. The conditioners were applied at a rate of 0.1% by weight. He observed that VAMA and HPAN treatments increased infiltration rate 5 to 10 times. Hedrick and Mowry (1952) added CRD-186 (calcium carboxylate polymer) and CRD-189 (sodium salt of hydrolized polyacrylonitrile) to Miami silt loam at a rate of 0.05% by weight. It was observed that infiltration rate for treated soil was 4.4 times that of untreated soil.

CHAPTER III

METHODS AND MATERIALS

A. Soil Materials

Materials studied were taken from the topsoil of Teller sandy loam (Udic Argiustolls), Tillman-Hollister clay loam (Typic Paleustolls and Pachic Paleustolls), and Cobb loamy sand (Udic Haplustalfs). Teller sandy loam contains 12% clay, 24% silt, and 64% sand. Tillman-Hollister clay loam contains 33.4% clay, 41.6% silt, and 25% sand. Cobb loamy sand contains 7.8% clay, 6.4% silt, and 85.8% sand.

Air-dried soil was ground to pass through a 2 mm sieve and was mixed in a mixer. Each soil was treated with different concentrations of super slurper (0.0, 0.025, 0.05, 0.1, 0.2, and 0.4% by weight). The soil with super slurper was mixed in a cylindrical container by rolling the container on the floor for 15 minutes.

B. Crust Strength Measurement

The modulus of rupture of artificially prepared crusts or briquets was measured for each soil treatment. The amount of force required to break each briquet was measured. The briquet breaking procedure was the same as that described by Reeve (1965). Briquets were prepared using brass molds 7 cm long, 3.5 cm wide, and 0.98 cm thick. A rectangular piece of 9 mesh screen was placed inside a tray. Five rectangular pieces of wiping paper 5 cm wide and 9 cm long were placed on the screen. Five molds were placed on the pieces of paper. Each mold was filled with soil by use of a tremie. Excess soil on top of each mold was removed without compaction. A thin layer of petroleum jelly was placed on the inside of each mold before filling to prevent the soil from adhering to the mold. The tray was filled with water such that water surrounded every mold. After one hour, the screen and the filled molds were transferred into another tray and were placed in an oven and dried for 24 hours at 52^{o} C. Ten briquets for each soil sample were prepared each time. Mass, width, and thickness of each briquet were measured after drying.

Figure 1 shows the sketch of the briquet breaking device, a soil briquet, and the parameters measured for the determination of the modulus of rupture. A briquet of width W and thickness T rested on the two lower bars of the briquet breaking device. The lower bars were separated by a distance L. The breaking force F was applied midway between the two lower bars. The briquet breaking device was located on one platform of a torsion balance. A container was attached to the other platform of balance. A briquet was placed on the lower bars of the briquet breaking device and the upper bar of the device was in contact with the briquet. Balance was adjusted on zero. A screw on top of the platform was lowered to be in contact with the upper bar of the briquet breaking device without exerting any pressure on the briquet. The breaking force was supplied by a constant flow of water into the container until the briquet was broken. The water flow was then diverted outside the container and the amount of water in the container was measured.

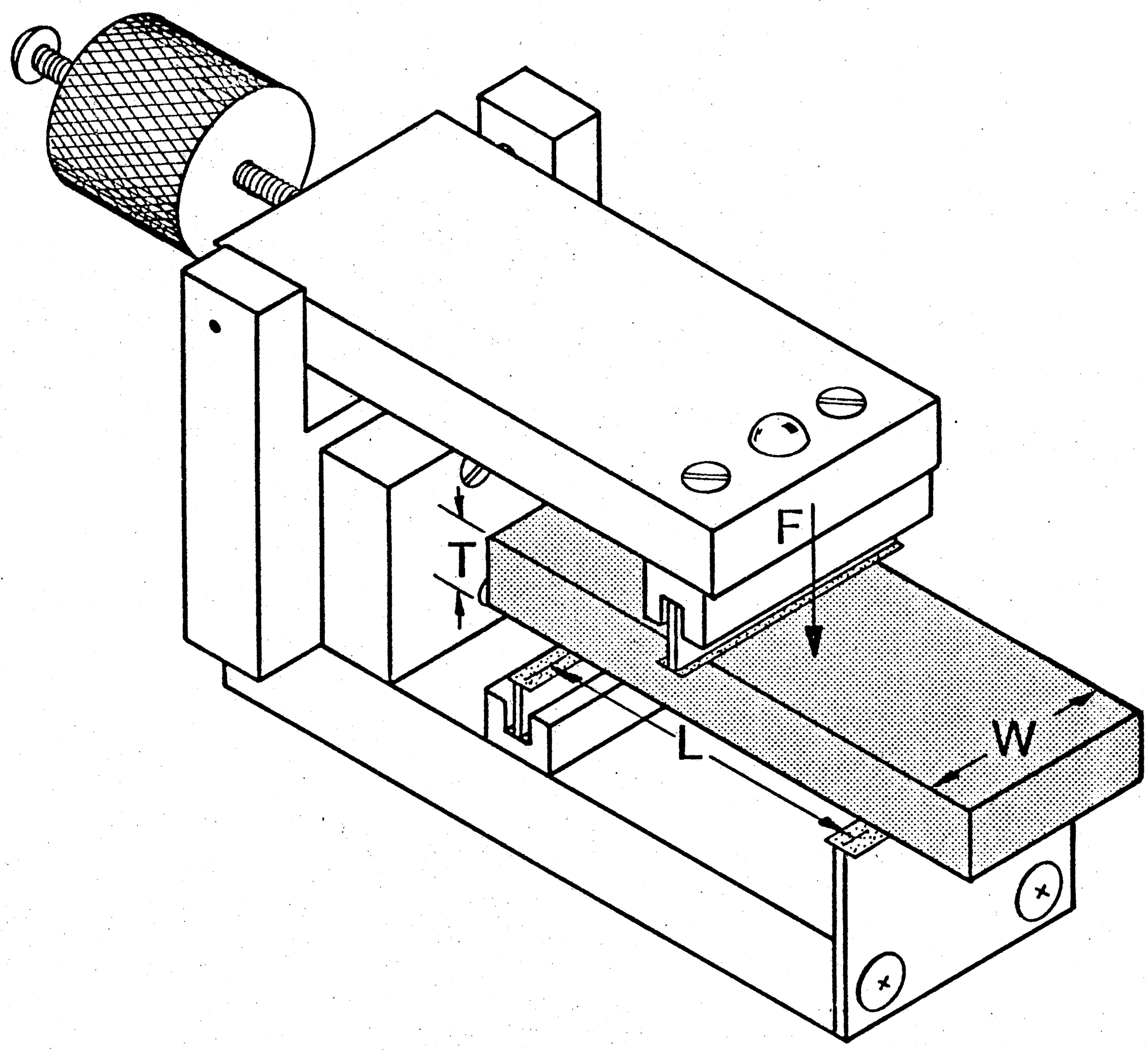

Figure 1. Diagram of the Briquet Breaking Device and a Soil Briquet of Width W and Thickness T Resting on the two Lower Bars, Separated by Distance L.

An overflow tank was used to supply a constant flow rate into the container. The overflow tank consisted of two plastic tubes and a 2,000 ml flask. One plastic tube was connected to the faucet and the other end of this tube was placed inside of the flask. A second plastic tube was used for outflow of water from the flask into the container on the balance. Overflow of water took place from the flask during the experiment. The desired constant flow rate was obtained by regulating the distance between the top of the flask and the end of the outflow tube. The flow rate which was used in this experiment was 2,006 grams per minute with 0.36% coefficient of variability.

After breaking of each briquet, the amount of water in the container and the thickness of the briquet at the rupture surface were measured. The modulus of rupture was calculated for each briquet by use of the equation

$$S = 3FL/2WT^2$$

where F is the breaking force (dyne), L is the distance between the two lower bars of the briquet breaking device (cm), W is the width of the briquet (cm), T is the thickness of the briquet (cm), and S is the modulus of rupture ($dyne/cm^2$). In this experiment, modulus of rupture was expressed in bars (1 bar = 10^6 dyne cm^{-2}).

The modulus of rupture was measured for ten briquets for each treatment. The water content of each briquet after breaking was measured on dry mass basis. The bulk density of each briquet was determined by dividing the mass of each dry briquet by the volume of the mold.

C. Water Retention Measurement

A pressure-membrane apparatus and a pressure-plate apparatus were used to measure the water content of soil samples at six different suctions (0.2, 0.5, 1.0, 4.9, 9.8, and 13.8 bars). The method of water retention measurement was the same as that described by Richards (1965).

For measurement of water content at high suctions (4.9, 9.8, and 13.8 bars) the pressure-membrane apparatus with cellulose acetate membrane was used. The screen base of the pressure membrane was inserted in the bottom plate. It was covered with a cellulose acetate membrane which was previously moistened. Rubber soil-retainer rings 5.5 cm in diameter and 0.97 cm high were used. Each time ten rubber rings were placed on the cellulose acetate membrane. Each ring was filled with soil by a spoon. The soil inside of each ring was leveled and was saturated with water. Each time, five of ten rings were filled with one treatment and the other five rings with another treatment. The pressure membrane gage was adjusted to the desired suction. After 48 hours when the soil samples approached equilibrium, the pressure membrane was opened. The soil samples were transferred into metal boxes for oven drying. Water content of each sample was determined on dry mass basis.

Soil water content at low suctions (0.2, 0.5, and 1.0 bars) were measured by means of a pressure plate. In this case, three ceramic plates were placed inside the pressure chamber. Ten rubber rings were placed on each ceramic plate, and each ring was filled with soil by a spoon. The soil inside of each ring was leveled and was saturated with water. Five rings on each ceramic plate were filled with one of six different treatments. The pressure chamber was closed. The pressure was adjusted to the desired suction. When the soil samples approached equilibrium, the pressure chamber was opened. The soil samples were transferred into metal boxes for oven drying. Water content for each sample was determined on dry mass basis.

D. Infiltration Rate Measurement

Figure 2 shows the experimental apparatus for measuring water infiltration into the soil. Twenty-five plexiglas rings 1.58 cm in diameter and 2 cm high were mounted in a wooden frame to form a 50 centimeter soil column. The bottom of the soil column was supported by a perforated plastic plate covered with glass wool. It was opened to the atmosphere at all times. The water applicator was a cylindrical plexiglas container with a perforated bottom. The water applicator was connected to a burette by plastic tube. The burette contained a Mariotte bubbling tube to maintain a constant head of 0.4 cm at the inlet. The burette was calibrated volumetrically.

For uniform compaction of the soil column, each plexiglas ring was filled with the same amount of soil and packed with a rubber stopper fastened to the end of a rod. The average bulk density of the soil column was calculated from the measured volume of the column and the mass of soil inside the column. The bulk density of each ring was also calculated by sectioning the column after the infiltration experiment was completed. The bulk density of the soil column and the rings provided information about the uniformity of compaction.

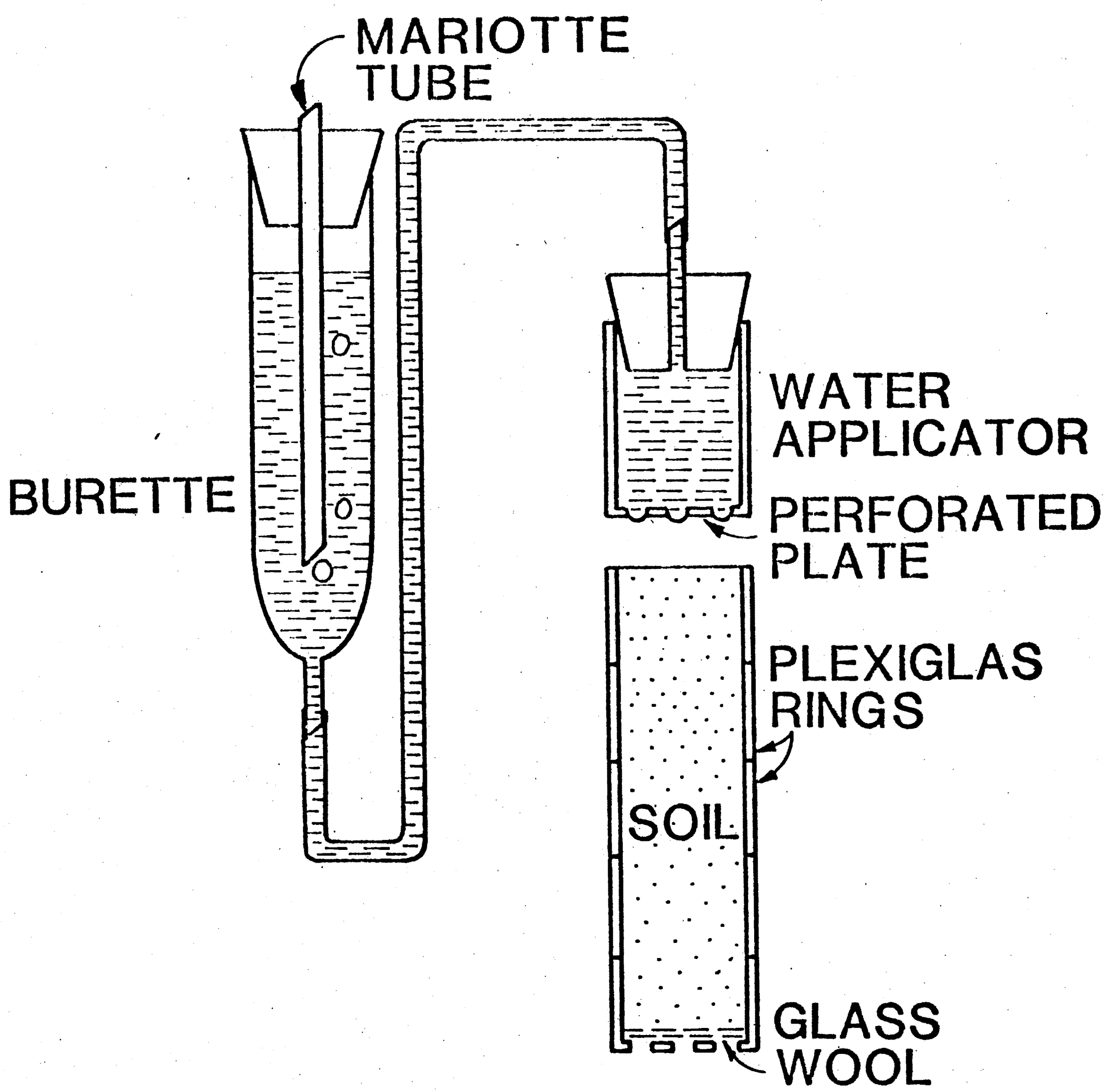

Figure 2. Diagram of Experimental Apparatus for Infiltration Rate Measurement.

To measure infiltration rate, the column of soil was placed on a jack beneath the water applicator. A stop watch was attached to the wooden frame near the top of the column. The column of soil was moved upward carefully, and was attached to the perforated plate of water applicator. The stop watch was engaged when soil column and perforated plate of water applicator came together and water moved into the soil column. The elapsed time was measured for each 5 cc of water that moved into the soil from the burette. Measurements were terminated when the wet front reached a depth of 40 cm. Infiltration measurements were made for three soil columns for each treatment.

CHAPTER IV

EXPERIMENTAL RESULTS AND DISCUSSION

A. Effect of Super Slurper on Modulus of Rupture

Figure 3 shows the effect of super slurper on modulus of rupture. In this figure, each curve is for one soil. Each point in each curve is the mean of ten replications. Each segmented vertical line represents plus and minus one standard deviation. Figure 3 shows that the modulus of rupture decreased as the concentration of super slurper increased for all three soils. Duncan's multiple range test was used to compare the effect of six different treatments on modulus of rupture. Table I shows the results of Duncan's multiple range test for all three soils. Table I shows that the differences between check and all other treatments except 0.025% super slurper were significant at 5% level for Teller sandy loam. Table I shows that the differences between check and all other treatments were significant at 5% level for Tillman-Hollister clay loam and also for Cobb loamy sand.

Different factors may cause reduction of modulus of rupture. Moisture content and bulk density are two of those factors. Figures 4 and 5 show the effect of super slurper on bulk density and water content of the briquets, respectively. In each figure, each curve is for one soil. Each point in the curves is the average of ten replications. Each

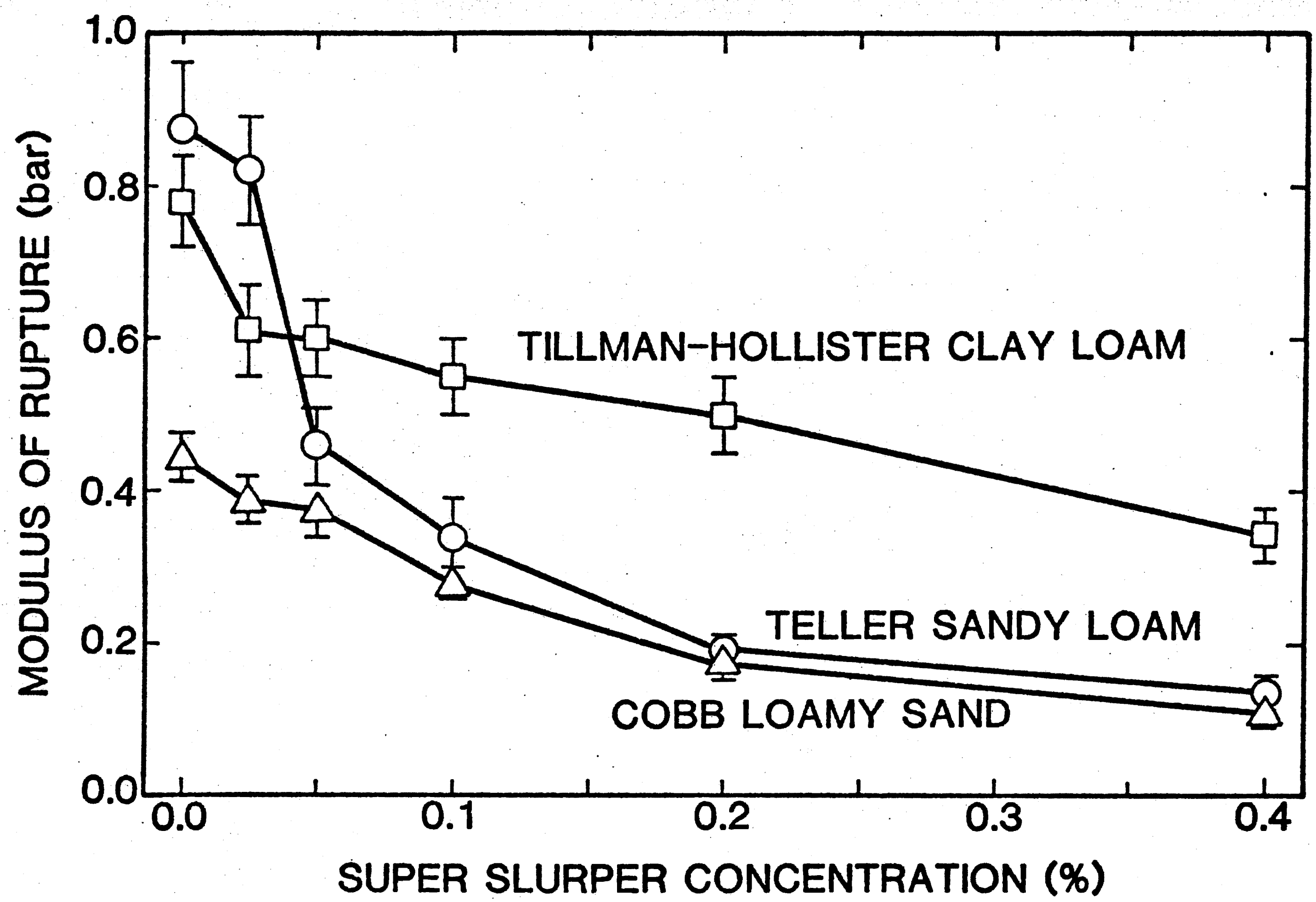

Figure 3. Effect of Super Slurper on Modulus of Rupture of Teller Sandy Loam, Tillman-Hollister Clay Loam, and Cobb Loamy Sand.

TABLE I

MODULUS OF RUPTURE FOR DIFFERENT TREATMENTS OF TELLER SANDY LOAM, TILLMAN-HOLLISTER CLAY LOAM, AND COBB LOAMY SAND

		Modulus of Rupture (Bars)		
Treatments (% Super Slurper)	Soils	Teller Sandy Loam	Tillman-Hollister Clay Loam	Cobb Loamy Sand
0.0		0.875 a*	0.776 a	0.441 a
0.025		0.817 a	0.614 b	0.389 b
0.05		0.461 b	0.601 b	0.374 b
0.1		0.343 c	0.548 b	0.280 c
0.2		0.191 d	0.495 b	0.176 d
0.4		0.142 d	0.341 c	0.112 e

* Values followed by the same letter for each soil are not significantly different at 5% level according to Duncan's multiple range test.

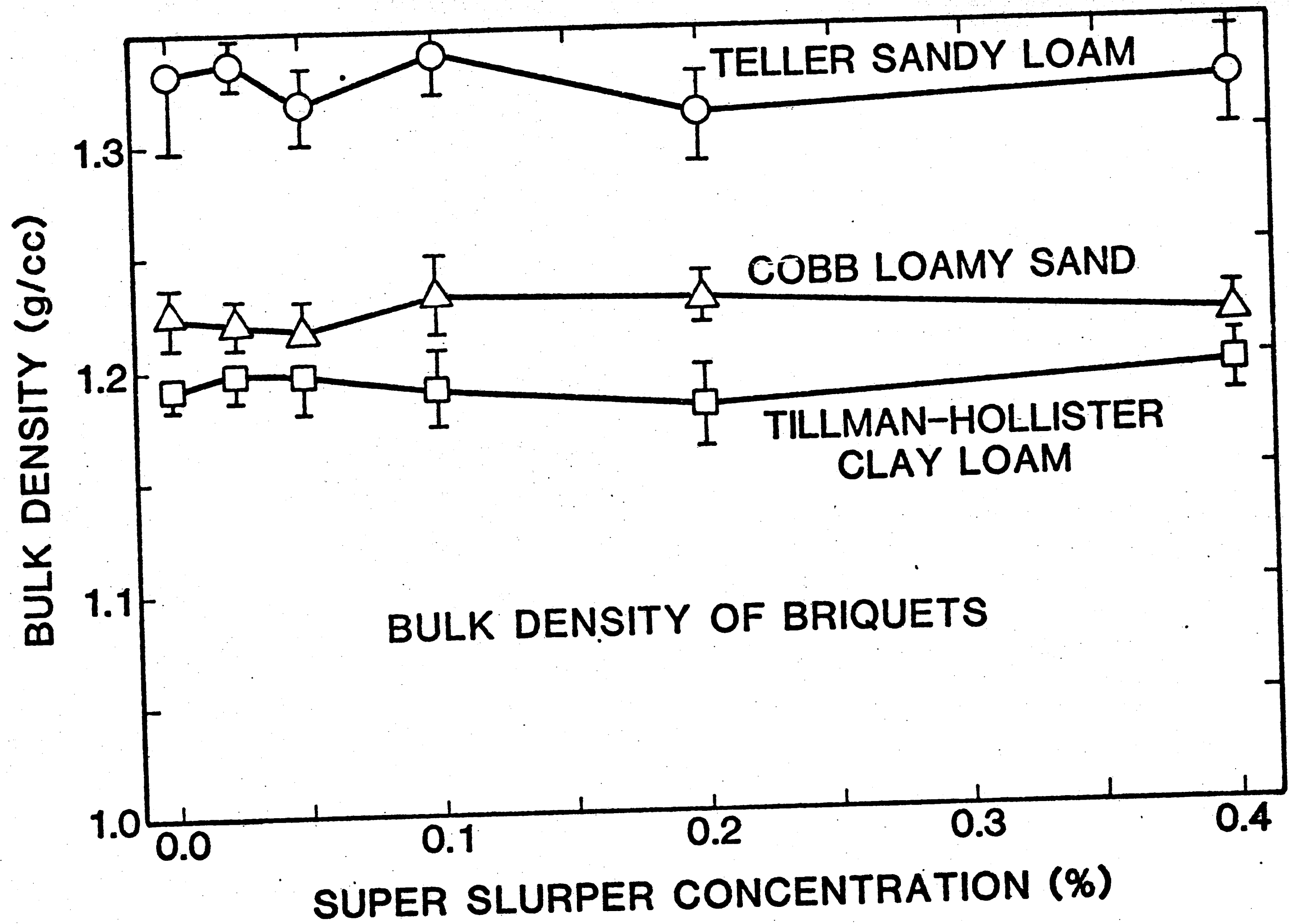

Figure 4. Average Bulk Density of Briquets of Teller Sandy Loam, Tillman-Hollister Clay Loam, and Cobb Loamy Sand, Used for Modulus of Rupture Measurement.

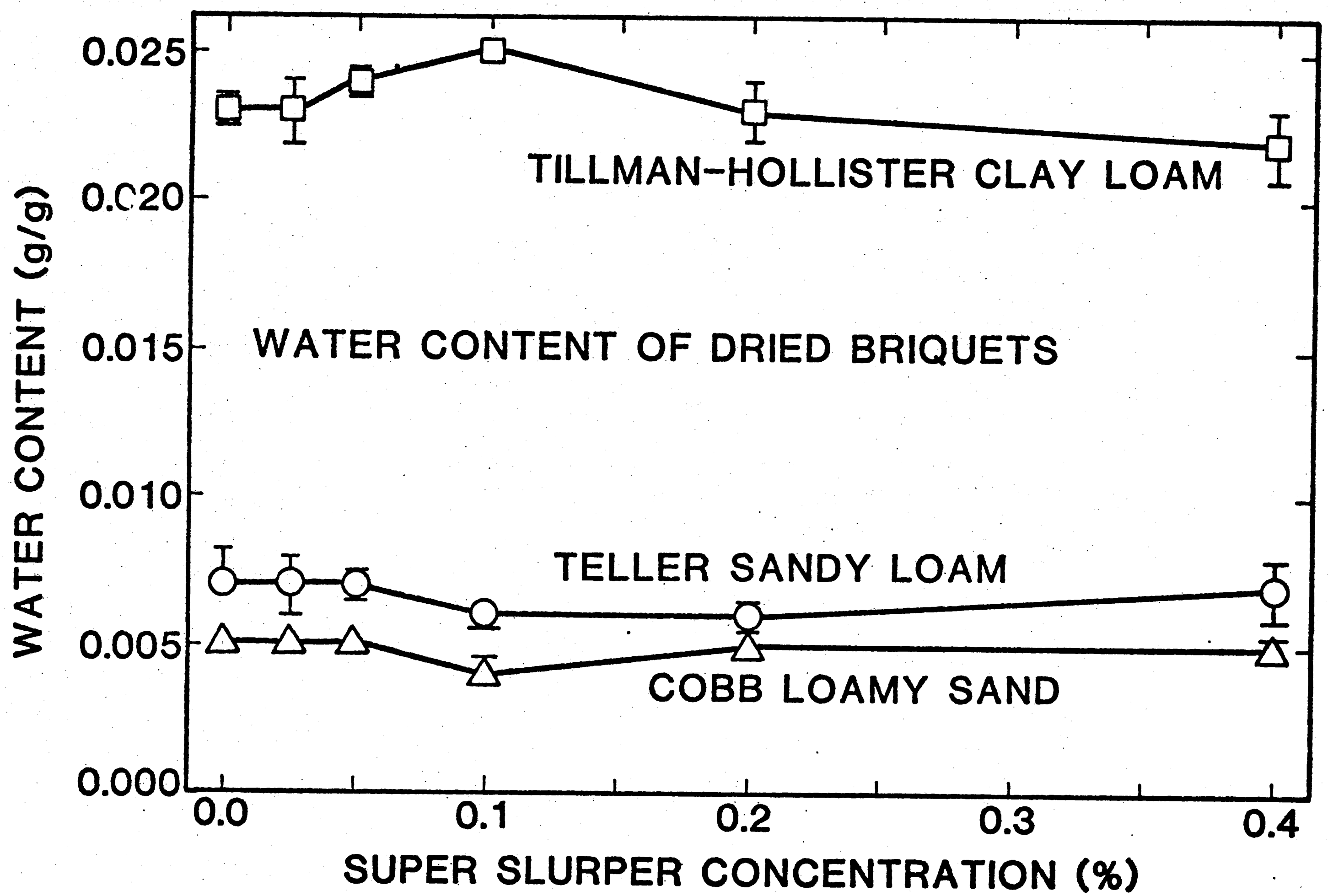

Figure 5. Average Water Content of Briquets of Teller Sandy Loam, Tillman-Hollister Clay Loam, and Cobb Loamy Sand, Used for Modulus of Rupture Measurement.

segmented vertical line represents plus and minus one standard deviation. The bulk densities of the different treatments for each soil shown in Figure 4 were not significantly different at the 5% level. This shows that reduction of modulus of rupture was not due to a decrease in bulk density. The water content of the briquets for the different treatments of each soil shown in Figure 5 were not significantly different at the 5% level. This shows that reduction of modulus of rupture was not due to an increase in water content.

Super slurper may be compared to other soil conditioners, such as VAMA (vinyl acetate-maleic acid copolymer) and or HPAN (hydrolized polyacrylonitrile) which have been used for prevention of soil crusting. Addition of 0.1% (by weight) VAMA or HPAN to San Luis sandy loam reduced modulus of rupture from 0.53 to 0.0 bars (Allison and Moore, 1956) while addition of 0.1% super slurper to Teller sandy loam decreased modulus of rupture from 0.87 to 0.34 bars in this experiment. Modulus of rupture decreased from 3.9 to 2.7 bars by addition of 0.1% (by weight) HPAN to Billings clay loam (Allison and Moore, 1956) while addition of 0.1% super slurper to Tillman-Hollister clay loam reduced modulus of rupture from 0.78 to 0.55 bars.

B. Effect of Super Slurper on Water Retention

Figures 6, 7, and 8 show the water content as a function of suction for three treatments of Teller sandy loam, Tillman-Hollister clay loam, and Cobb loamy sand, respectively. Each figure shows the water retention curves for check (no treatment), 0.2, and 0.4% super slurper. In each figure, each point is the average of ten replications.

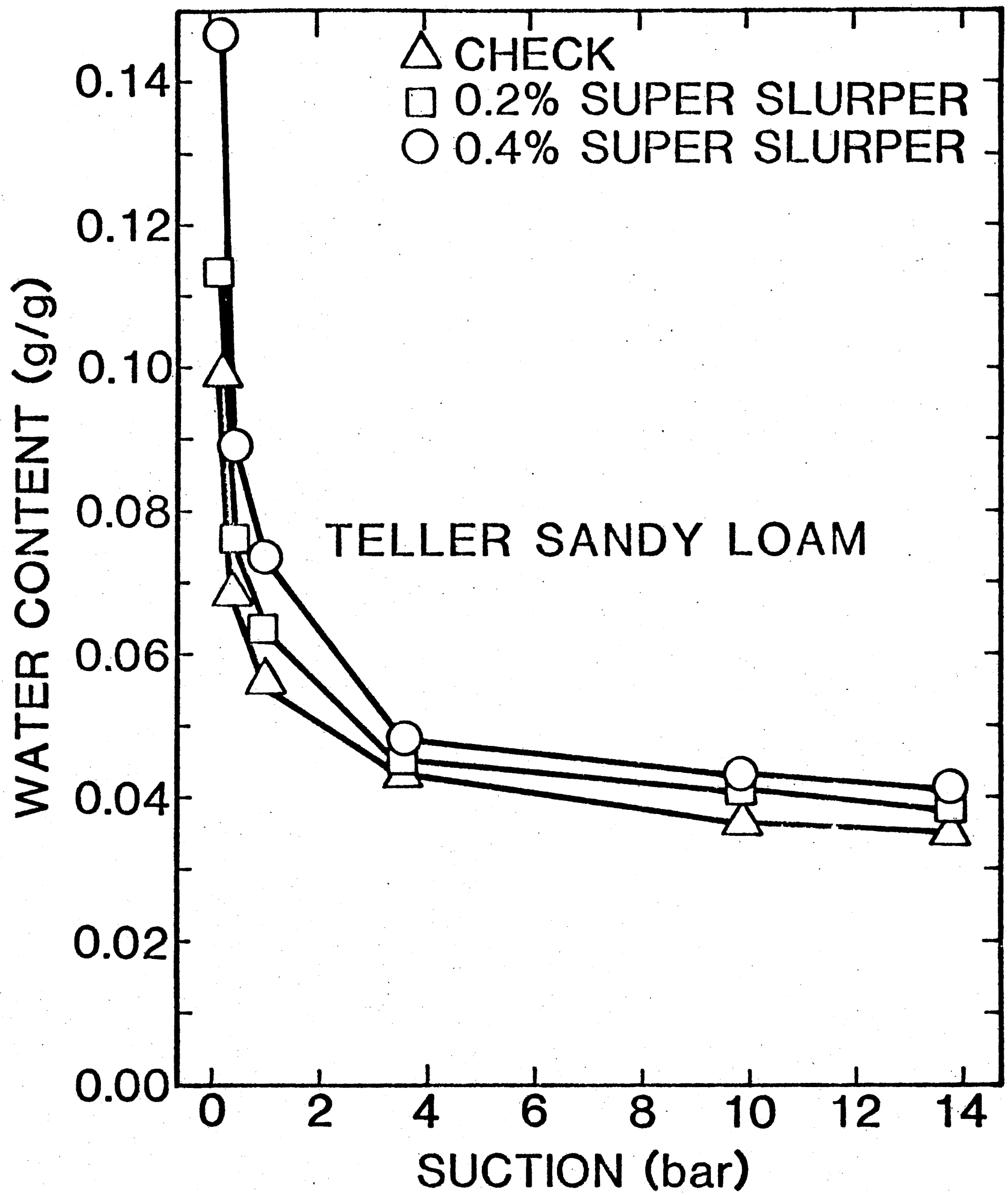

Figure 6. Effect of Super Slurper on the Water Retention Curve of Teller Sandy Loam.

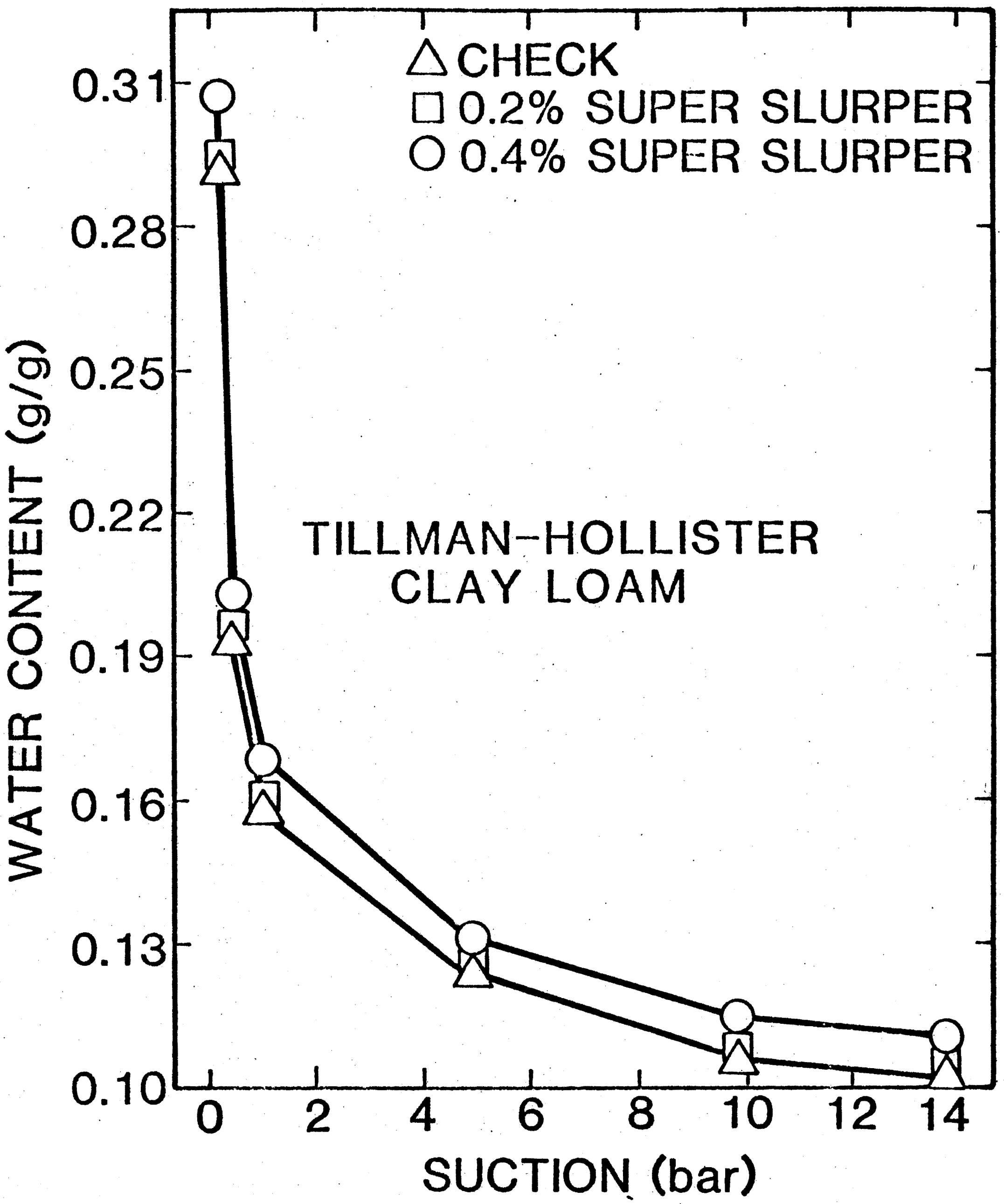

Figure 7. Effect of Super Slurper on the Water Retention Curve of Tillman-Hollister Clay Loam.

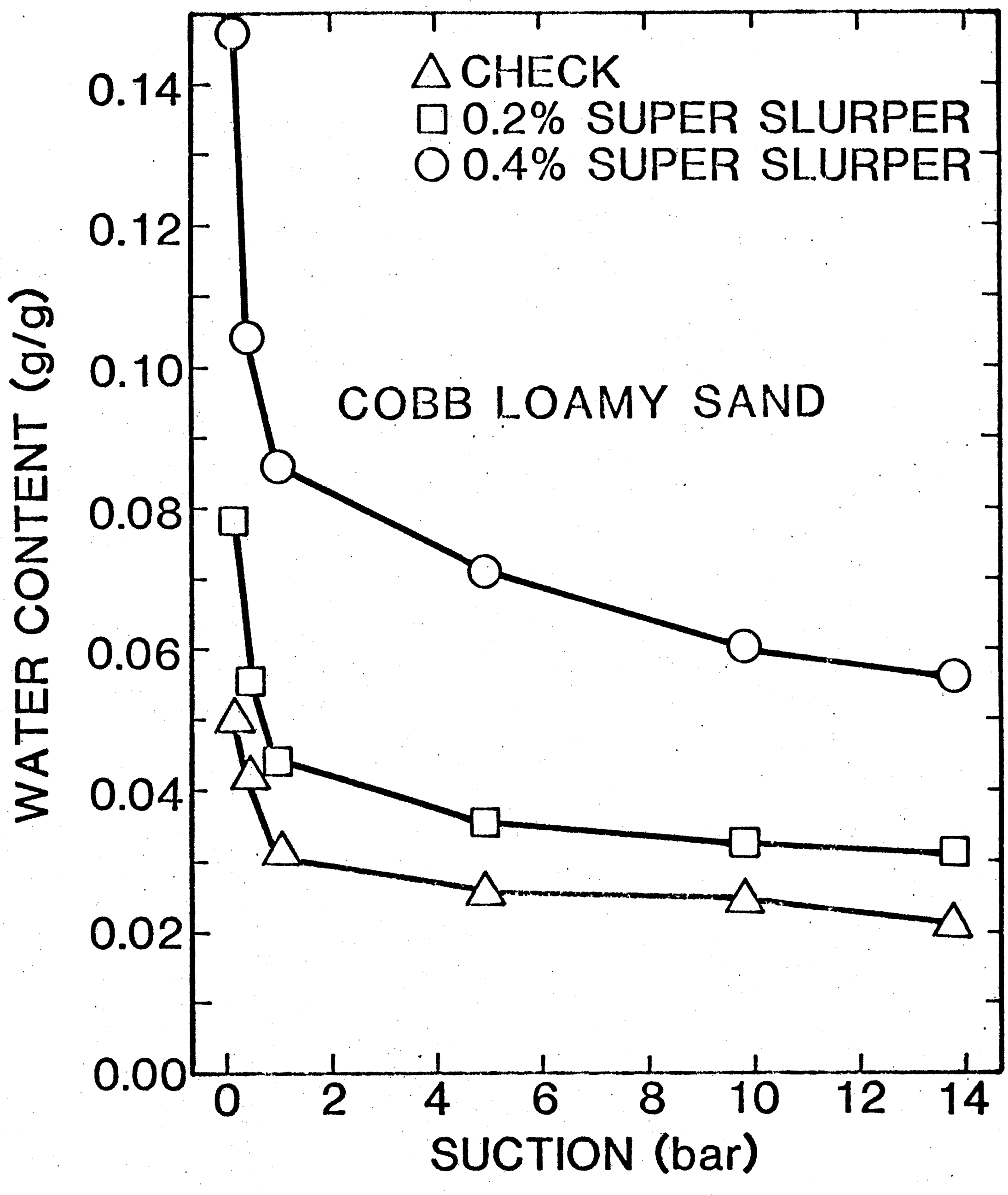

Figure 8. Effect of Super Slurper on the Water Retention Curve of Cobb Loamy Sand.

For each kind of soil, six different treatments (0.0, 0.025, 0.05, 0.1, 0.2, and 0.4% super slurper) were compared to each other at each of six suctions (0.2, 0.5, 1.0, 4.9, 9.8, and 13.8 bars) using the Duncan's multiple range test. Tables II, III, and IV show the results of the Duncan's multiple range test for Teller sandy loam, Tillman-Hollister clay loam, and Cobb loamy sand, respectively.

In general, super slurper at concentrations of 0.0, 0.025, 0.05, and 0.1% did not increase water retention of Teller sandy loam and Cobb loamy sand. Super slurper at concentrations of 0.4 and 0.2% increased water retention of Teller sandy loam and Cobb loamy sand. The amount of water retained was more for the treatment with 0.4% super slurper than for the treatment with 0.2% super slurper. The amount of water retained was more for the treatment with 0.2% super slurper than for the untreated soil. The increase in water content at each suction for Cobb loamy sand was more than for Teller sandy loam. Super slurper at concentrations of 0.0, 0.025, 0.05, 0.1, and 0.2% did not increase water retention of Tillman-Hollister clay loam. Super slurper at concentration of 0.4% increased water retention of Tillman-Hollister clay loam. The changes in water content due to super slurper were greater at lower suctions than at higher suctions for Teller sandy loam and Cobb loamy sand (Figures 6 and 7). This suggests that super slurper may increase the ability of these soils to store water for plant use. The changes in water content of treatments at low suctions were approximately the same as the changes at high suctions for Tillman-Hollister clay loam.

TABLE II

WATER RETENTION (G/G) FOR SIX DIFFERENT TREATMENTS OF TELLER SANDY LOAM

Treatments (% Super Slurper)	Suction (Bars)					
	0.2	0.5	1.0	4.9	9.8	13.8
0.0	0.099 a	*0.068 a	0.057 a	0.044 a	0.036 a	0.036 a
0.025	0.092 a	0.068 a	0.056 a	0.041 a	0.036 a	0.035 a
0.05	0.096 a	0.067 a	0.053 a	0.041 a	0.035 a	0.034 a
0.1	0.103 a	0.068 a	0.056 a	0.041 a	0.036 a	0.036 a
0.2	0.114 b	0.076 b	0.064 b	0.044 b	0.041 b	0.038 b
0.4	0.146 c	0.089 c	0.074 c	0.048 c	0.043 c	0.041 c

* Values followed by the same letter at each suction are not significantly different at 5% level according to Duncan's multiple range test.

TABLE III

WATER RETENTION (G/G) FOR SIX DIFFERENT TREATMENTS OF TILLMAN-HOLLISTER CLAY LOAM

	Suction (Bars)					
Treatments (% Super Slurper)	0.2	0.5	1.0	4.9	9.8	13.8
0.0	0.292 a*	0.193 a	0.158 a	0.125 a	0.108 a	0.102 a
0.025	0.275 b	0.191 a	0.154 a	0.123 a	0.108 a	0.102 a
0.05	0.275 b	0.190 a	0.137 b	0.124 a	0.110 a	0.103 a
0.1	0.270 b	0.184 a	0.143 b	0.125 a	0.109 a	0.104 a
0.2	0.293 a	0.194 a	0.159 a	0.126 a	0.108 a	0.105 a
0.4	0.307 c	0.203 b	0.168 c	0.131 b	0.115 b	0.111 b

* Values followed by the same letter at each suction are not significantly different at 5% level according to Duncan's multiple range test.

TABLE IV

WATER RETENTION (G/G) FOR SIX DIFFERENT TREATMENTS OF COBB LOAMY SAND

Treatments (% Super slurper)	Suction (Bars) 0.2	0.5	1.0	4.9	9.8	13.8
0.0	0.050 a*	0.042 a	0.031 a	0.026 a	0.024 a	0.021 a
0.025	0.055 a	0.043 a	0.031 a	0.027 a	0.025 a	0.021 a
0.05	0.053 a	0.038 a	0.029 a	0.026 a	0.024 a	0.024 b
0.1	0.056 a	0.044 a	0.031 a	0.028 a	0.026 a	0.026 c
0.2	0.078 b	0.055 b	0.044 b	0.035 b	0.033 b	0.031 d
0.4	0.147 c	0.104 c	0.086 c	0.071 c	0.060 c	0.056 e

* Values followed by the same letter at each suction are not significantly different at 5% level according to Duncan's multiple range test.

C. Effect of Super Slurper on Infiltration Rate

Figures 9 and 10 show the results of the experiment to determine the effect of super slurper on infiltration rate of Teller sandy loam. Philip's equation for cumulative infiltration as a function of time ($I = ST^{\frac{1}{2}} + AT$, where I is the cumulative infiltration, T is the elapsed time, A is a parameter which depends upon the ability of soil to transmit water, and S is sorptivity) was used to describe the data. The solid lines shown in each figure were obtained by fitting the curve by least-square method. Figure 9 shows the cumulative infiltration curves for one replication for treated and untreated Teller sandy loam. Philip's equation fits the experimental data very well. Three infiltration experiments were conducted for each treatment. Figure 10 shows the extremes of the fitted functions for treated and untreated Teller sandy loam. The third curve for 0.4% super slurper falls between the two curves shown. Only one curve is shown for the check because the cumulative infiltration curves for the three replications coincide. These figures show that super slurper decreases the water infiltration rates for Teller sandy loam.

Figures 11, 12, 13, and 14 show similar results for Tillman-Hollister clay loam and Cobb loamy sand soils. In each case, Philip's equation fits the experimental data very well. In each case, the treated soils have lower infiltration rates than the untreated soils although the differences are not as great as those observed in the Teller sandy loam. Table V shows the coefficients of the fitted curves. The sorptivities of the soils treated with super slurper were 38, 18, and 11% less than the sorptivities of the untreated sandy loam, clay loam, and loamy sand soils, respectively.

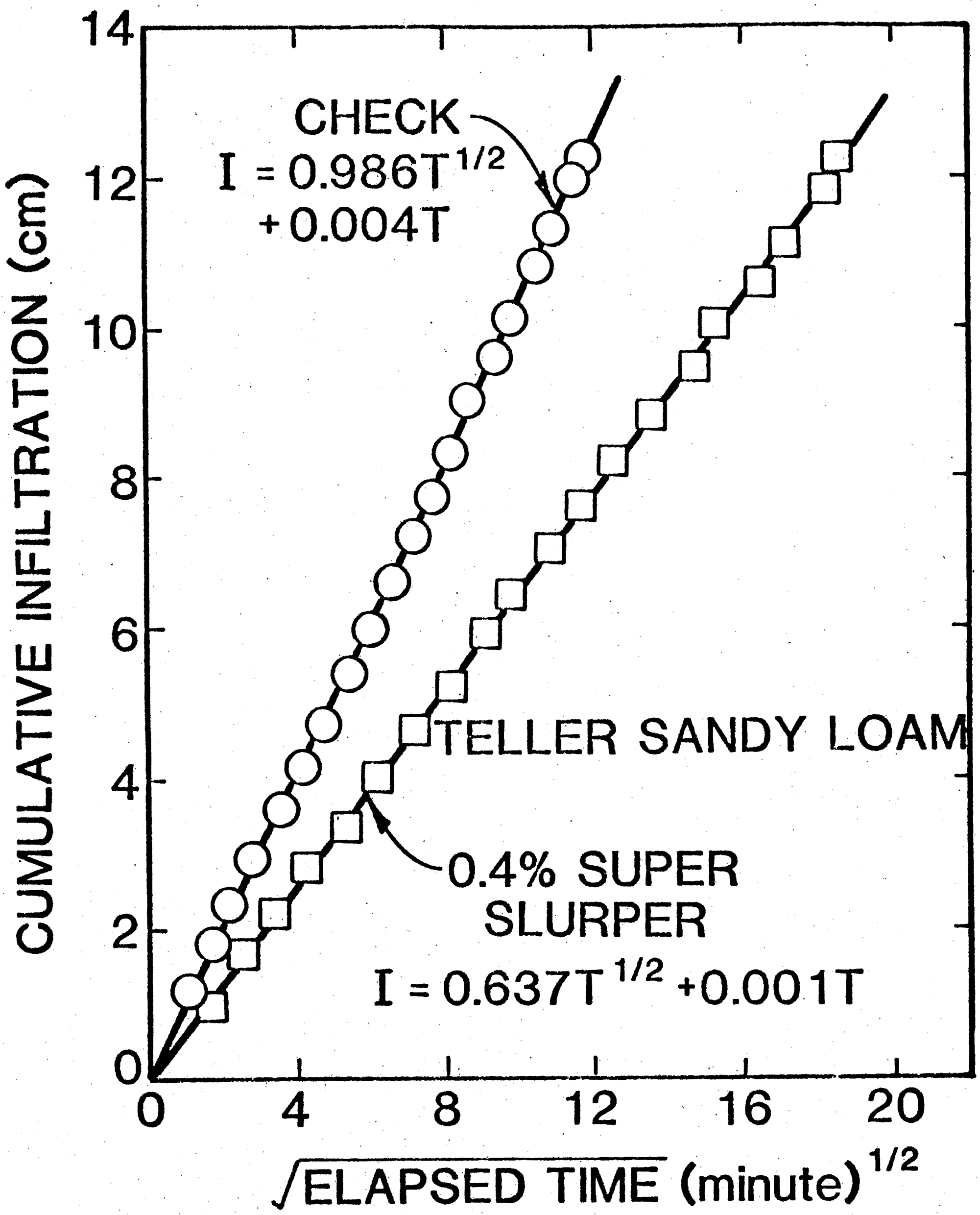

Figure 9. Effect of Super Slurper on the Cumulative Infiltration of Teller Sandy Loam.

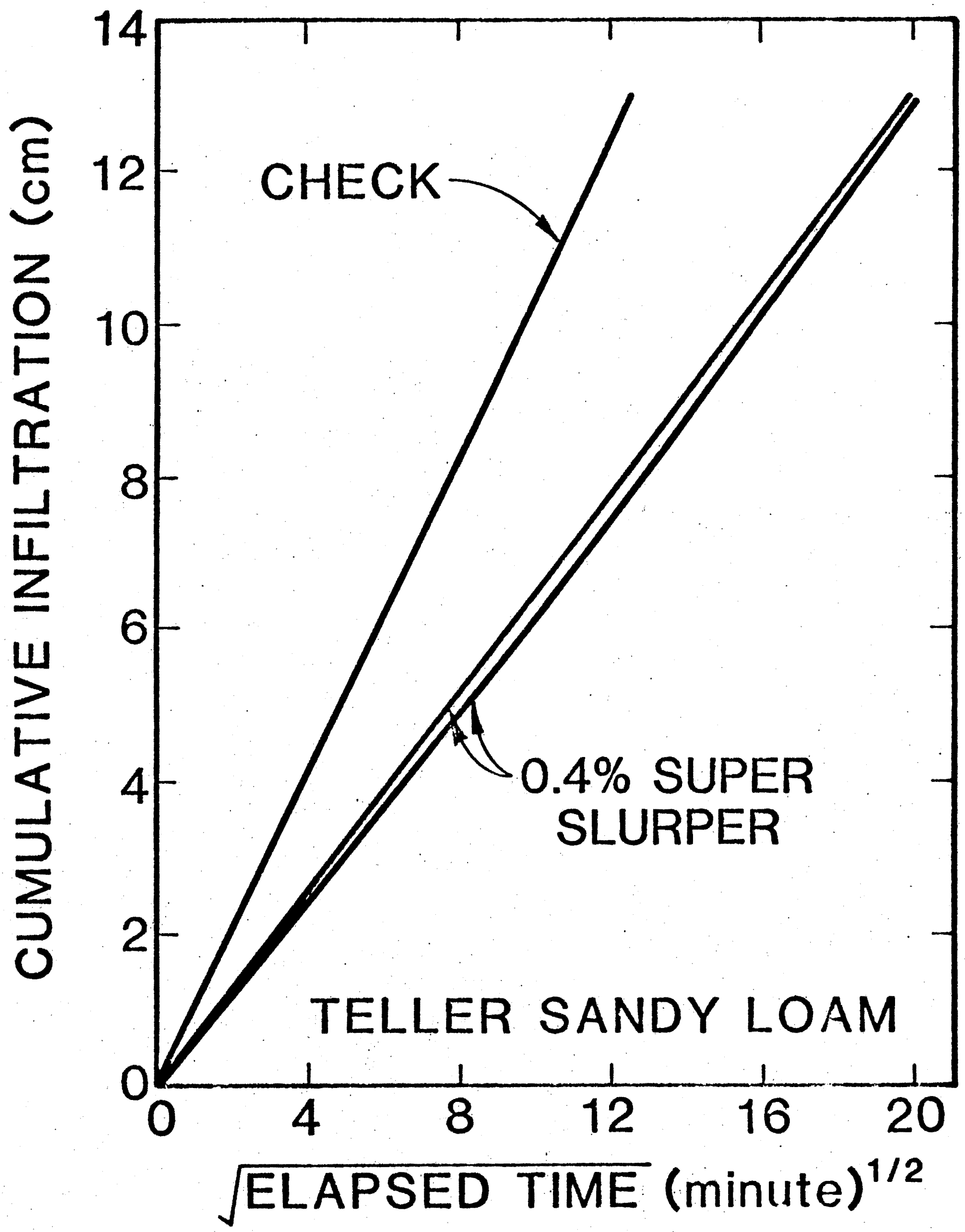

Figure 10. Cumulative Infiltration Curves for Different Replications of Treated and Untreated Teller Sandy Loam.

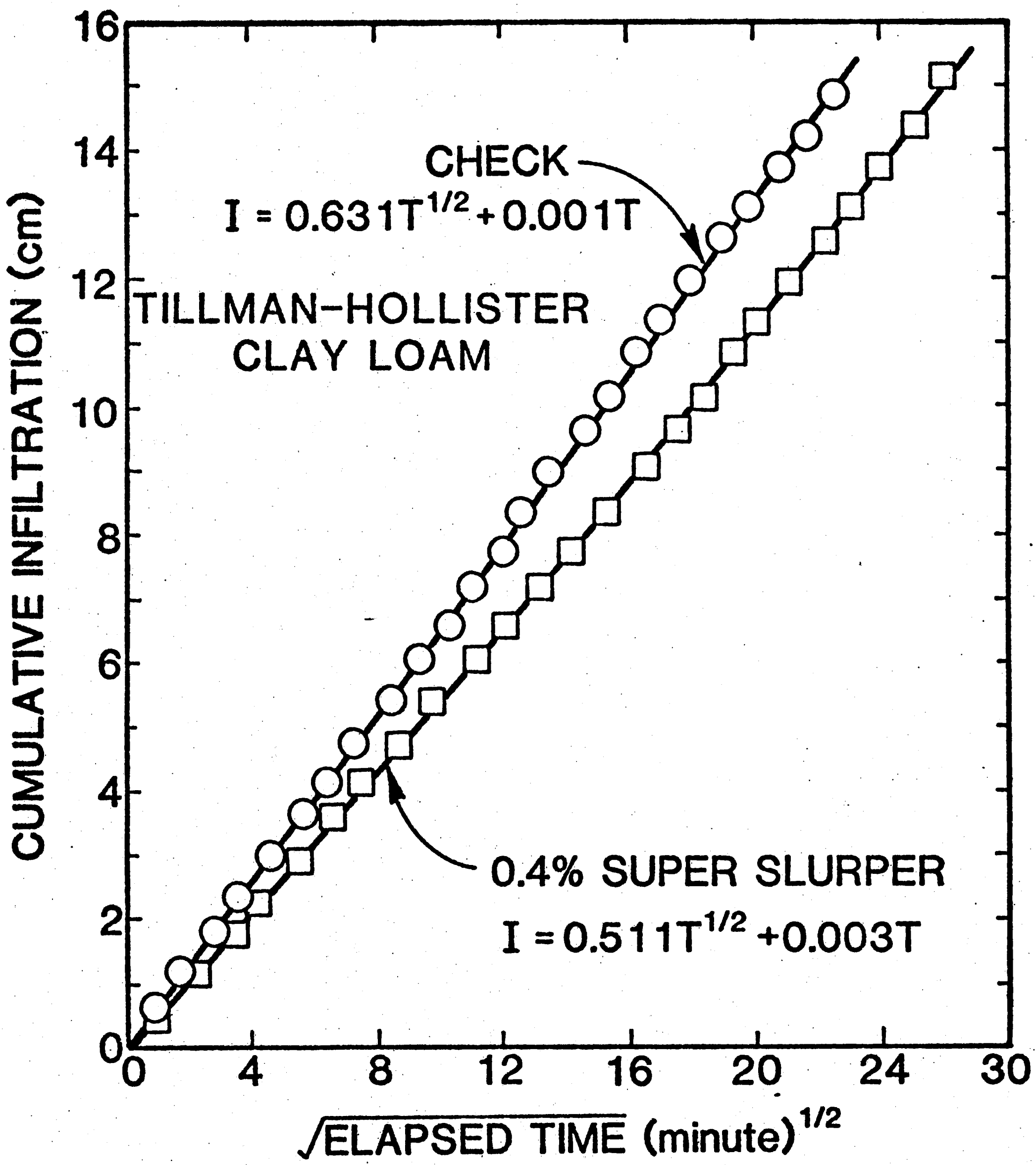

Figure 11. Effect of Super Slurper on Cumulative Infiltration of Tillman-Hollister Clay Loam.

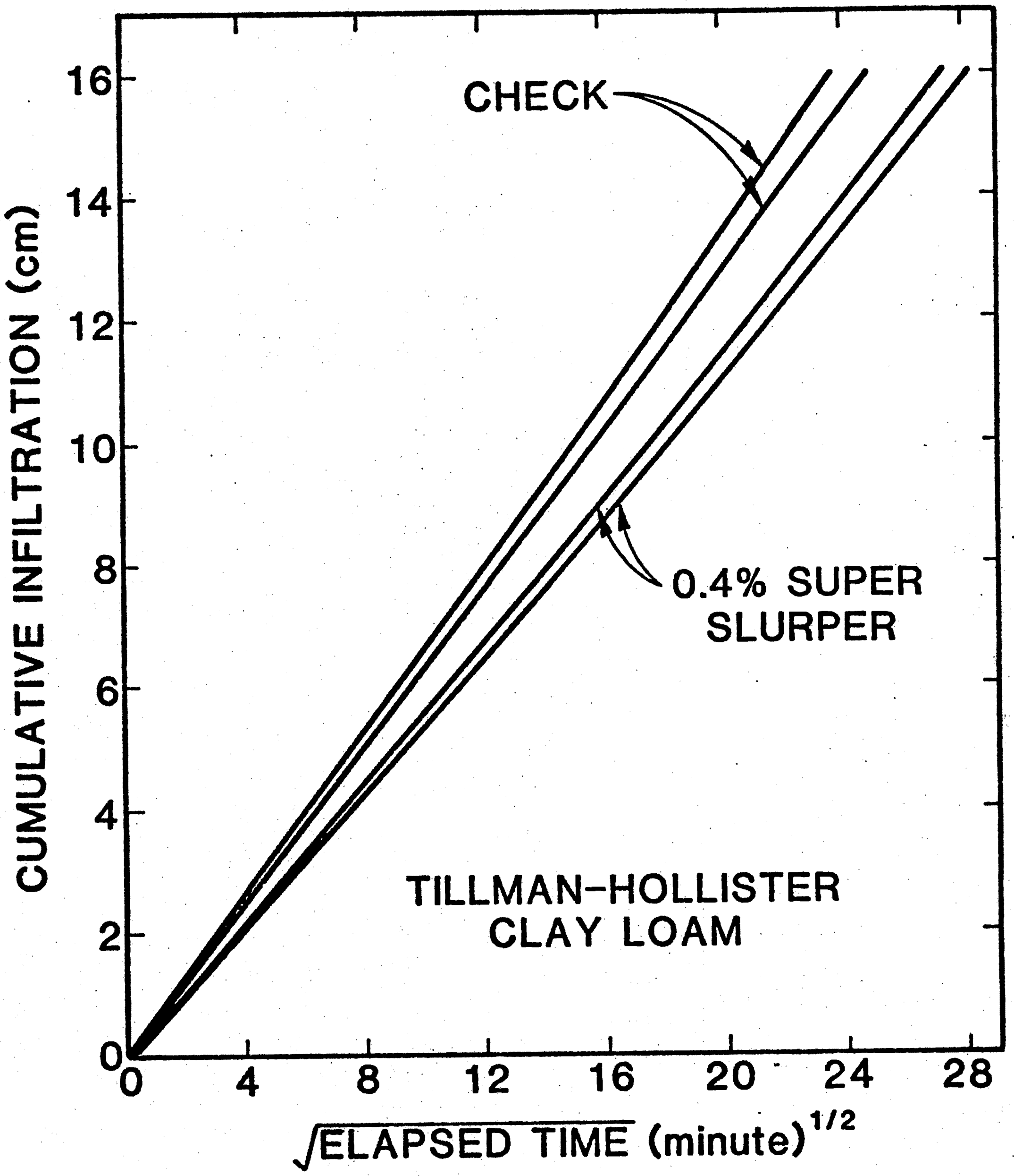

Figure 12. Cumulative Infiltration Curves for Different Replications of Treated and Untreated Tillman-Hollister Clay Loam.

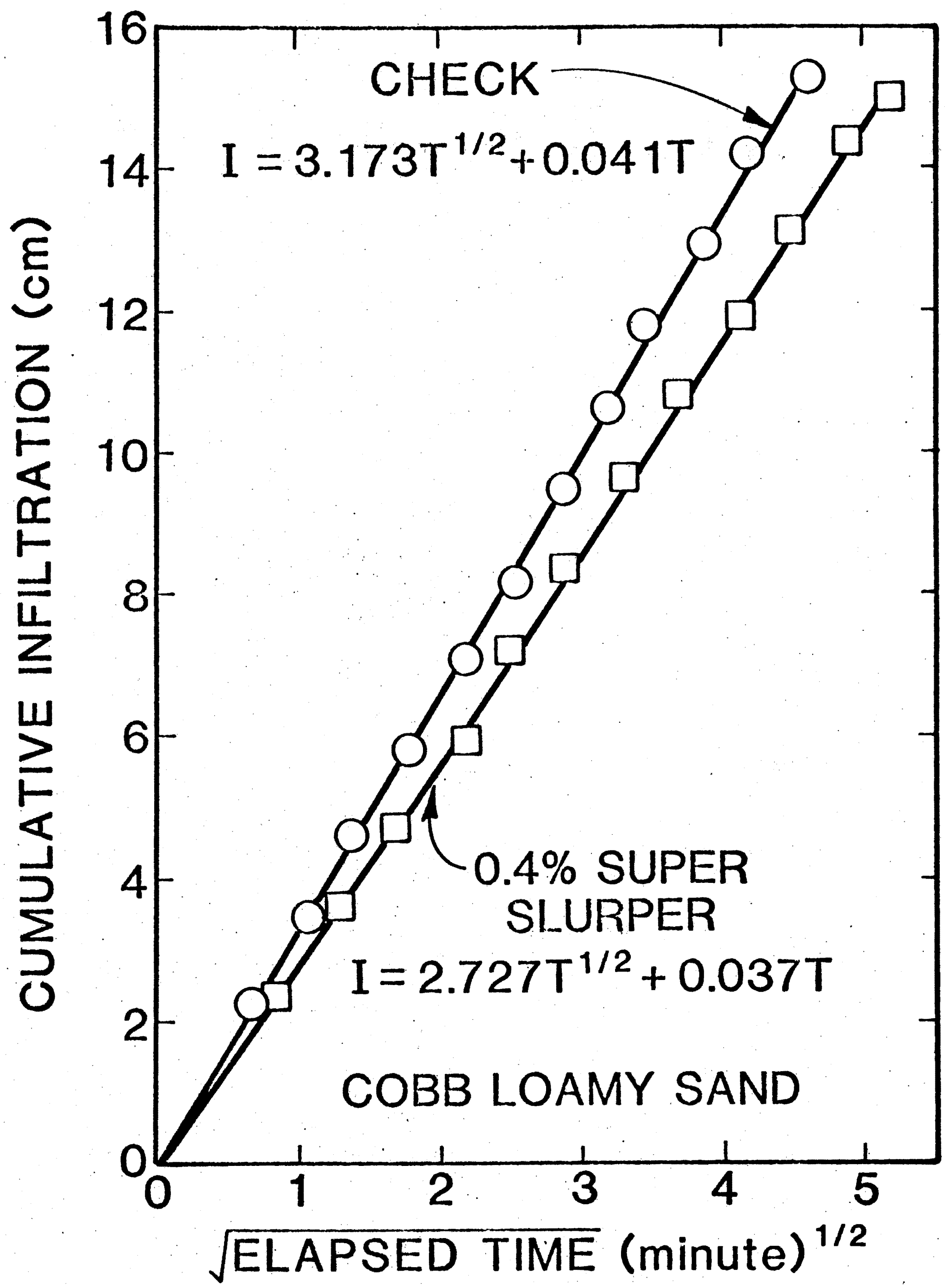

Figure 13. Effect of Super Slurper on the Cumulative Infiltration of Cobb Loamy Sand.

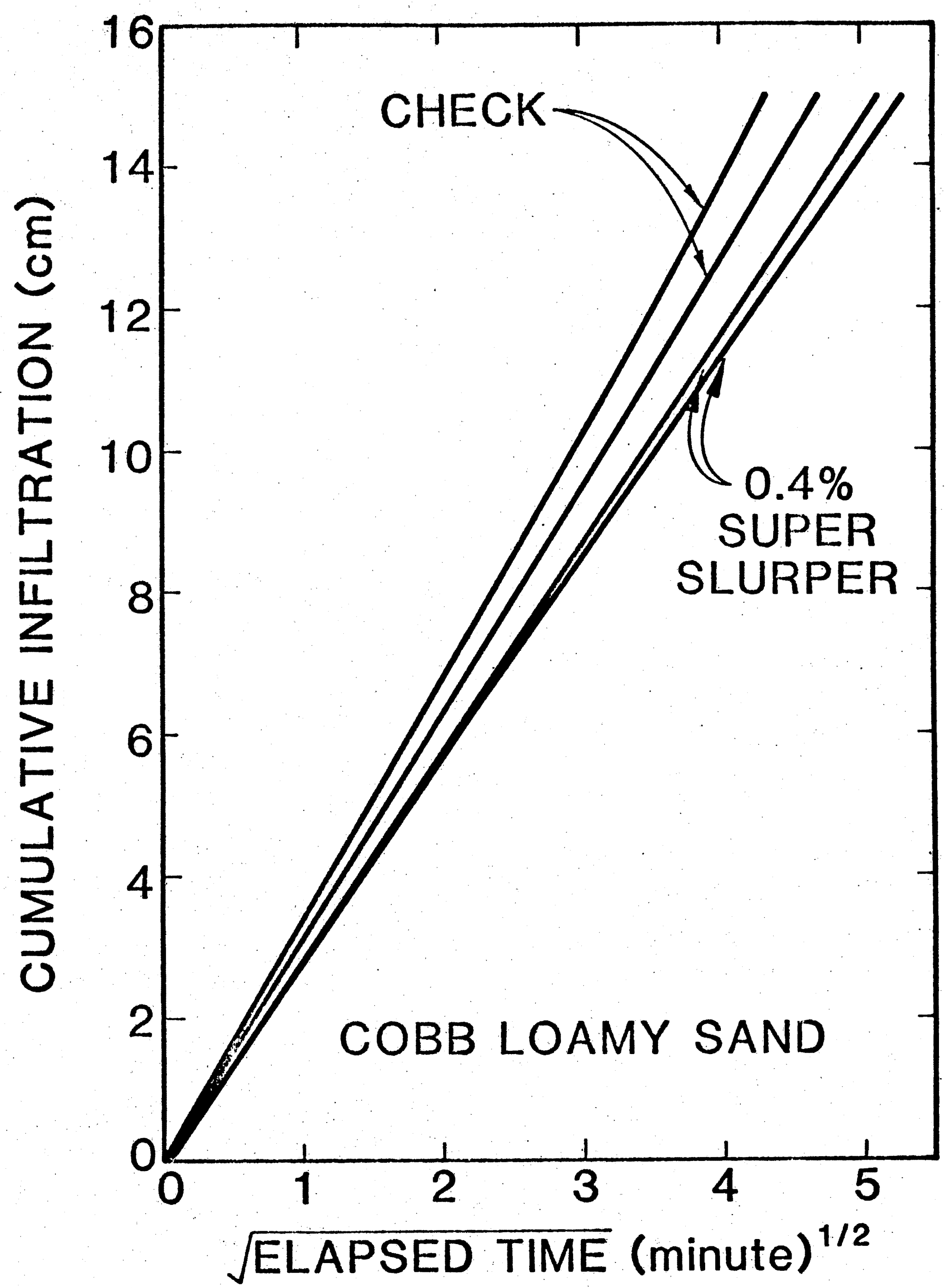

Figure 14. Cumulative Infiltration Curves for Different Replications of Treated and Untreated Cobb Loamy Sand.

TABLE V

COEFFICIENTS (S AND A) OF INFILTRATION EQUATION ($I = ST^{\frac{1}{2}} + AT$) FOR EACH REPLICATION OF EACH TREATMENT

		Treatments			
		Check		0.4% Super Slurper	
Soil	Replication	S	A	S	A
Teller sandy loam	1	0.986	0.0041	0.587	0.0027
	2	1.030	-0.0002	0.637	0.0007
	3	0.990	0.0038	0.635	0.0013
Tillman-Hollister clay loam	1	0.615	0.0012	0.513	0.0019
	2	0.645	0.0013	0.511	0.0025
	3	0.631	0.0014	0.531	0.0020
Cobb loamy sand	1	3.173	0.0407	2.727	0.0365
	2	3.274	0.0385	2.909	-0.0164
	3	3.125	0.0163	2.843	0.0171

Figures 15, 16, and 17 show the bulk densities of the representative treated and untreated soil columns as functions of distance from the inlet. These data were obtained by sectioning the columns after completing the infiltration experiment. The average bulk density and the variation in bulk density were nearly the same for the treated and untreated soils. This suggests that the reduction of infiltration rate and sorptivity were not due to higher compaction of the treated soil.

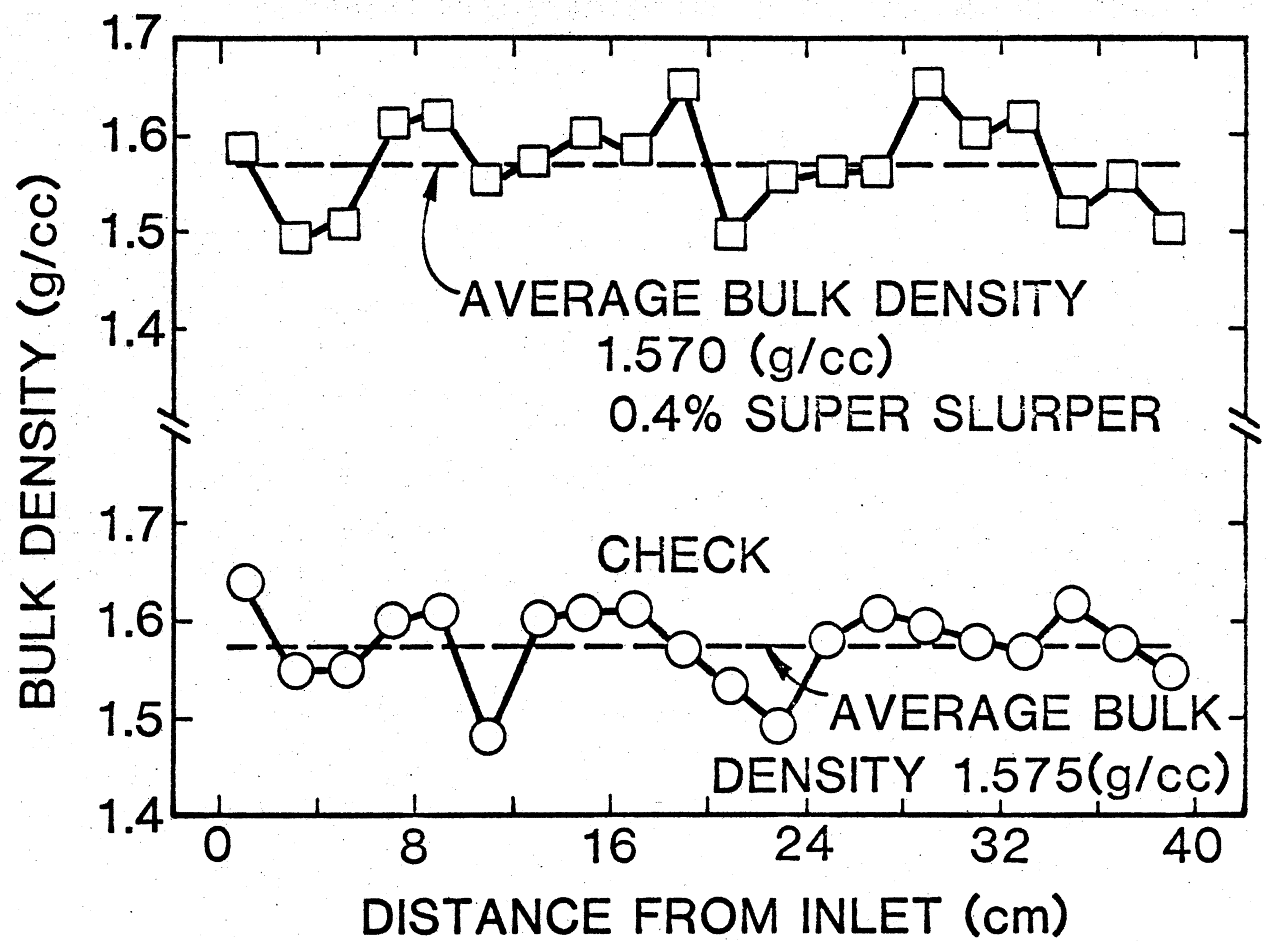

Figure 15. Bulk Density for Each Two-Centimeters of Soil Column and Average Bulk Density of the Soil Column for Teller Sandy Loam.

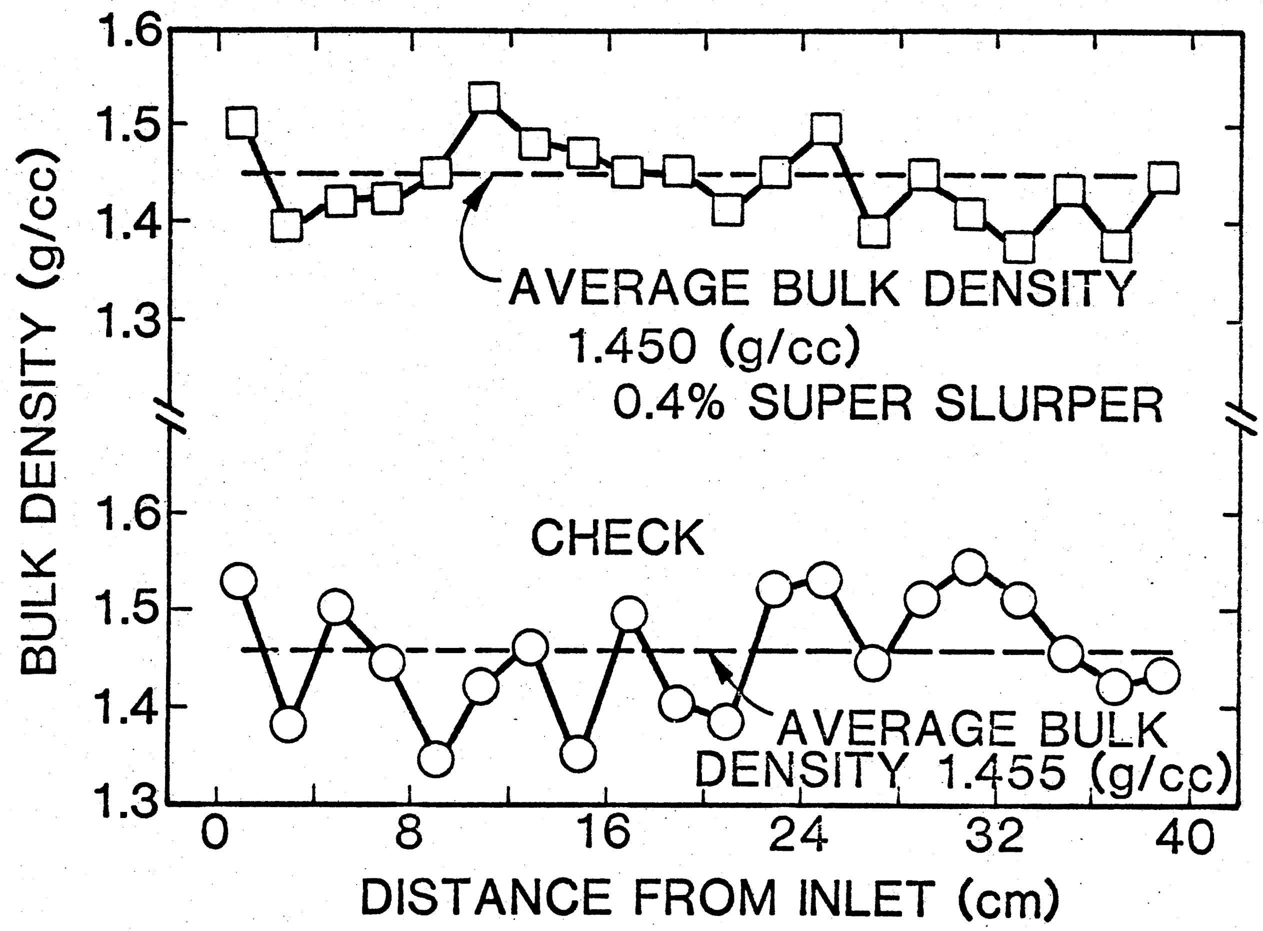

Figure 16. Bulk Density for Each Two-Centimeters of Soil Column and Average Bulk Density of the Soil Column for Tillman-Hollister Clay Loam.

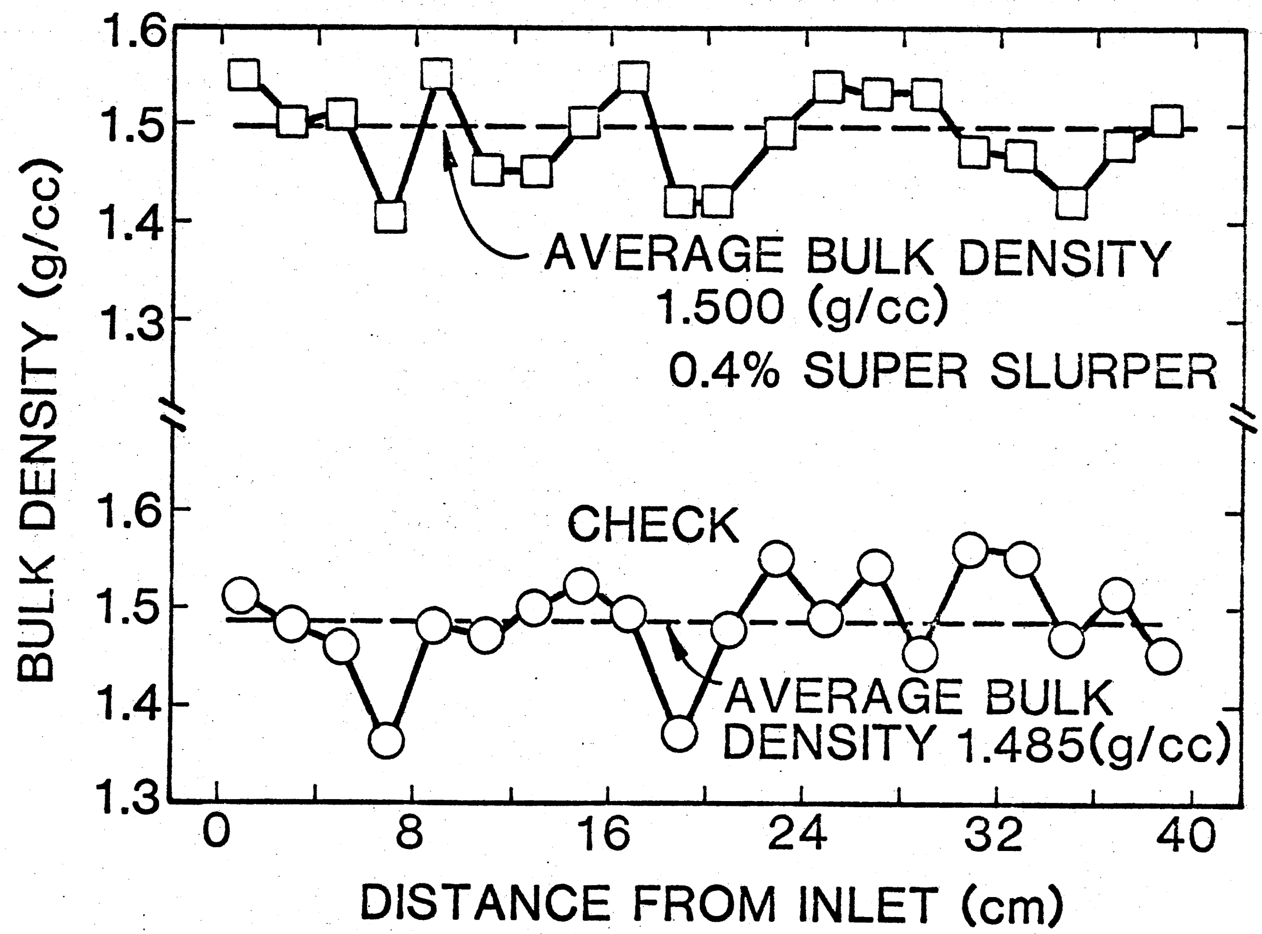

Figure 17. Bulk Density for Each Two-Centimeters of Soil Column and Average Bulk Density of the Soil Column for Cobb Loamy Sand.

CHAPTER V

SUMMARY

Super slurper decreased crust strength as measured by the modulus of rupture for three different soils. The decrease in strength was greatest at the highest concentration of super slurper. Modulus of rupture was reduced 84, 74.5, and 54% for Teller sandy loam, Tillman-Hollister clay loam, and Cobb loamy sand, respectively, by addition of 0.4% super slurper. The reduction of modulus of rupture was not due to a decrease in bulk density or an increase in water content.

Super slurper at concentrations of 0.025, 0.05, and 0.1% by weight did not have any effect on water retention of Teller sandy loam and Cobb loamy sand. Super slurper at concentrations of 0.2 and 0.4% increased water retention of Teller sandy loam and Cobb loamy sand. The water retained in the soil treated with 0.4% super slurper was greater than that retained in soil treated with 0.2% super slurper. The increase was greater for Cobb loamy sand than for Teller sandy loam. Super slurper at concentrations of 0.025, 0.05, and 0.1, and 0.2% by weight did not increase water retention of Tillman-Hollister clay loam. Super slurper at concentration of 0.4% increased water retention of Tillman-Hollister clay loam.

Super slurper at concentration of 0.4% decreased the infiltration rate of Teller sandy loam, Tillman-Hollister clay loam, and Cobb loamy sand. The sorptivity decreased 38, 13, and 11% for Teller sandy loam, Tillman-Hollister clay loam, and Cobb loamy sand treated with 0.4% super slurper, respectively.

LITERATURE CITED

Allison, L. E. 1952. Effect of synthetic polyelectrolytes on the structure of saline and alkali soils. Soil Sci. 73:443-454.

Allison, L. E. 1956. Soil and plant responses to VAMA and HPAN soil conditioners in the presence of high exchangeable sodium. Soil Sci. Soc. Am. Proc. 20:147-151.

Allison, L. E., and D. C. Moore. 1956. Effect of VAMA and HPAN soil conditioners on aggregation, surface crusting, and moisture retention in alkali soils. Soil Sci. Soc. Am. Proc. 20:143-146.

Bennett, O. L., D. A. Ashley, and B. D. Doss. 1964. Methods of reducing soil crusting to increase cotton seedling emergence. Agro. J. 56:162-165.

Bouyoucos, G. J. 1939. Effect of organic matter on the water holding capacity and the wilting point of mineral soils. Soil Sci. 47:377-383.

Cameron, D. R. Variability of soil water retention curves and predicted hydraulic conductivities on a small plot. 1978. Soil Sci. 126:364-371.

Carnes, A. 1934. Soil crusts—methods of study, their strength, and a method of overcoming their injury to cotton stands. Agr. Eng. 15:167-169.

Childs, E. C. 1940. The use of soil moisture characteristics in soil studies. Soil Sci. 50:239-252.

Dement, J. D., W. P. Martin, G. S. Taylor, and E. K. Alban. 1955. Effect of field applications of synthetic soil-aggregate stabilizer on plant emergence. Soil Sci. 79:25-31.

Evans, D. D., and S. W. Buol. 1968. Micromorphological study of soil crusts. Soil Sci. Soc. Am. Proc. 32:19-22.

Free, G. R. 1952. Soil movement by raindrops. Agr. Eng. 33:491-494.

Hedrick, R. M., and D. T. Mowry. 1952. Effect of synthetic polyelectrolytes on aggregation, aeration, and water relationships of soil. Soil Sci. 73:427-440.

Hillel, D. 1971. Soil and Water: Physical Principles and Processes. Academic Press, New York and London. 56-77P.

Holder, C. B. and K. W. Brown. 1974. Evaluation of simulated seedling emergence through rainfall-induced soil crusts. Soil Sci. Soc. Am. Proc. 38:705-709.

Israelsen, O. W., and V. E. Hansen. 1962. Irrigation Principles and Practices. Ed. 3. John Wiley and Sons, Inc., New York. 152P.

Jamison, V. C. 1954. The effect of some soil conditioners on friability and compactability of soil. Soil Sci. Soc. Am. Proc. 18:391-394.

Kostiakov, A. N. 1932. On the dynamics of the coefficient of water percolation in soils and on the necessity for studying it from a dynamic point of view for purposes of amelioration. Tran. 6th. Int. Congr. Soil Sci. Russian Part A:17-21.

Kowsar, A., L. Boersma, and G. D. Jarman. 1969. Effect of petroleum mulch on soil-water content and soil temperature. Soil Sci. Soc. Am. Proc. 33:783-786.

Lewis, M. R., and W. L. Powers. 1938. A study of factors affecting infiltration rate. Soil Sci. Soc. Am. Proc. 3:334-339.

Lutz, J. F. 1947. Apparatus for collecting undisturbed soil samples. Soil Sci. 64:399-401.

Morton, C. T., and W. F. Buchele. 1960. Emergence energy of plant seed seedling. Agr. Eng. 41:428-431.

Neal, J. H., and L. D. Baver. 1937. Measuring the impact of raindrop. J. Am. Soc. Agro. 29:708-709.

Parker, J. J. and H. M. Taylor. 1965. Soil strength and seedling emergence relations. I. Soil type, moisture tension, temperature, and planting depth effects. Agro. J. 57:289-291.

Peters, D. B., R. M. Hagan, and G. B. Bodman. 1953. Available moisture capacities of soils as affected by additions of polyelectrolyte soil conditioners. Soil Sci. 75:467-471.

Petezval, L. and J. F. Lutz. 1957. Soil crusting and some factors affecting it. Soil Sci. Soc. Am. Proc. 21:485-491.

Philip, J. R. 1957. The theory of infiltration:4. Sorptivity and algebraic infiltration equations. Soil Sci. 84:257-263.

Rawitz, E., and A. Hazan. 1978. The effect of stabilized hydrophobic aggregate layer properties on soil water regime and seedling emergence. Soil Sci. Soc. Am. J. 42:787-793.

Reeve, R. C. 1965. Modulus of rupture, P. 466-471. In C. A. Black. Methods of Soil Analysis, Part I. Agronomy No. 9.

Richards, L. A. 1952. Report of the subcommittee on permeability and infiltration, committee on terminology, soil science society of America. Soil Sci. Soc. Am. Proc. 16:85-88.

Richards, L. A. 1953. Modulus of rupture as an index of crusting of soil. Soil Sci. Soc. Am. Proc. 17:321-323.

Richards, L. A. 1965. Physical condition of water in soil, P. 128-137. In C. A. Black. Methods of Soil Analysis, Part I. Agronomy No. 9.

Reitemeier, R. F., and J. E. Christiansen. 1946. The effect of organic matter, gypsum, and drying on the infiltration rate and permeability of a soil irrigated with a high sodium water. Trans. Am. Geophys. Union 27:181-186.

Robbins, C. W., D. L. Carter, and G. E. Leggett. 1972. Controlling soil crusting with phosphoric acid to enhance seedling emergence. Agron. J. 64:180-183.

Shrader, W. D. and A. Mostejeran. 1976. Potentials of a polyacrylonitrile-starch polymer super slurper to modify water holding properties of soils. Master Thesis, Iowa State University, Ames, Iowa.

Stauffer, L. H. 1927. Measurement of physical characteristics of soils. Soil Sci. 24:373-379.

Tackett, J. L., and R. W. Pearson. 1965. Some characteristics of soil crusts formed by simulated rainfall. Soil Sci. 99:407-413.

Weaver, M. O., G. F. Fanta, and W. M. Doane. 1974. Hydrolized starch-polyacrylonitrile. Northern Regional Laboratory, Agricultural Research Service, U. S. Dept. of Agri., Peoria, Illinois.

APPENDICES

APPENDIX A

EXPERIMENTAL DATA FOR MODULUS OF RUPTURE

TABLE VI

MODULUS OF RUPTURE (BAR) FOR TEN REPLICATIONS OF EACH TREATMENT FOR TELLER SANDY LOAM

Replication	Treatments (%Super Slurper)					
	0.0	0.025	0.05	0.1	0.2	0.4
1	1.045	0.747	0.426	0.333	0.185	0.149
2	0.907	0.856	0.429	0.309	0.205	0.156
3	0.909	0.836	0.454	0.366	0.177	0.141
4	0.971	0.872	0.543	0.309	0.210	0.136
5	0.845	0.817	0.523	0.307	0.194	0.141
6	0.822	0.686	0.409	0.310	0.206	0.145
7	0.817	0.881	0.523	0.360	0.220	0.141
8	0.816	0.869	0.446	0.395	0.185	0.134
9	0.790	0.851	0.440	0.412	0.161	0.164
10	0.823	0.757	0.420	0.328	0.162	0.117
Mean	0.875	0.817	0.461	0.343	0.191	0.142
Standard Deviation	0.082	0.065	0.049	0.038	0.019	0.013

TABLE VII

BULK DENSITY (G/CC) OF THE BRIQUETS FOR TEN
REPLICATIONS OF EACH TREATMENT
FOR TELLER SANDY LOAM

Replication	Treatments (%Super Slurper)					
	0.0	0.025	0.05	0.1	0.2	0.4
1	1.363	1.325	1.323	1.348	1.313	1.330
2	1.345	1.335	1.322	1.338	1.290	1.314
3	1.371	1.321	1.307	1.332	1.286	1.323
4	1.316	1.314	1.311	1.319	1.308	1.309
5	1.382	1.305	1.364	1.337	1.339	1.343
6	1.275	1.337	1.290	1.341	1.290	1.303
7	1.306	1.353	1.314	1.338	1.321	1.317
8	1.281	1.341	1.294	1.328	1.306	1.296
9	1.334	1.351	1.333	1.338	1.324	1.357
10	1.306	1.339	1.298	1.329	1.320	1.314
Mean	1.328	1.332	1.316	1.335	1.310	1.321
Standard Deviation	0.035	0.015	0.021	0.008	0.016	0.018

TABLE VIII

MOISTURE CONTENT (G/G) OF THE BRIQUETS FOR TEN REPLICATIONS OF EACH TREATMENT FOR TELLER SANDY LOAM

Replication	Treatments (% Super Slurper)					
	0.0	0.025	0.05	0.1	0.2	0.4
1	0.006	0.007	0.008	0.006	0.007	0.007
2	0.006	0.007	0.007	0.006	0.007	0.008
3	0.007	0.007	0.008	0.006	0.006	0.008
4	0.006	0.008	0.007	0.007	0.006	0.007
5	0.007	0.007	0.007	0.006	0.006	0.007
6	0.008	0.008	0.007	0.006	0.007	0.007
7	0.006	0.007	0.008	0.006	0.006	0.008
8	0.006	0.007	0.008	0.007	0.006	0.007
9	0.007	0.006	0.008	0.006	0.006	0.008
10	0.007	0.007	0.007	0.006	0.006	0.007
Mean	0.007	0.007	0.007	0.006	0.006	0.007
Standard Deviation	0.0007	0.0005	0.0005	0.0004	0.0005	0.0005

TABLE IX

MODULUS OF RUPTURE (BAR) FOR TEN REPLICATIONS OF EACH TREATMENT FOR TILLMAN-HOLLISTER CLAY LOAM

Replication	Treatments (% Super Slurper)					
	0.0	0.025	0.05	0.1	0.2	0.4
1	0.797	0.618	0.530	0.558	0.466	0.362
2	0.821	0.629	0.616	0.513	0.560	0.383
3	0.798	0.589	0.590	0.494	0.510	0.349
4	0.725	0.624	0.661	0.601	0.425	0.329
5	0.851	0.682	0.666	0.503	0.488	0.360
6	0.610	0.507	0.549	0.619	0.437	0.302
7	0.778	0.523	0.661	0.627	0.529	0.337
8	0.804	0.661	0.622	0.541	0.512	0.325
9	0.767	0.624	0.548	0.549	0.558	0.346
10	0.809	0.679	0.567	0.475	0.463	0.317
Mean	0.776	0.614	0.601	0.548	0.495	0.341
Standard Deviation	0.066	0.059	0.051	0.053	0.047	0.028

TABLE X

BULK DENSITY (G/CC) OF THE BRIQUETS FOR TEN REPLICATIONS OF EACH TREATMENT FOR TILLMAN-HOLLISTER CLAY LOAM

Replication	Treatments (% Super Slurper)					
	0.0	0.025	0.05	0.1	0.2	0.4
1	1.178	1.198	1.203	1.189	1.172	1.186
2	1.172	1.199	1.213	1.179	1.186	1.179
3	1.191	1.211	1.188	1.177	1.158	1.187
4	1.179	1.194	1.174	1.169	1.176	1.177
5	1.207	1.191	1.216	1.200	1.185	1.201
6	1.175	1.170	1.163	1.156	1.190	1.211
7	1.177	1.178	1.168	1.195	1.182	1.207
8	1.193	1.188	1.177	1.186	1.178	1.191
9	1.189	1.191	1.194	1.195	1.185	1.198
10	1.198	1.199	1.205	1.218	1.183	1.180
Mean	1.186	1.192	1.190	1.186	1.180	1.192
Standard Deviation	0.011	0.011	0.018	0.017	0.009	0.011

TABLE XI

MOISTURE CONTENT (G/G) OF THE BRIQUETS FOR TEN REPLICATIONS OF EACH TREATMENT FOR TILLMAN-HOLLISTER CLAY LOAM

Replication	Treatments (% Super Slurper)					
	0.0	0.025	0.05	0.1	0.2	0.4
1	0.023	0.024	0.024	0.025	0.025	0.024
2	0.024	0.022	0.025	0.025	0.024	0.023
3	0.023	0.023	0.024	0.025	0.024	0.022
4	0.023	0.024	0.024	0.025	0.024	0.023
5	0.024	0.024	0.024	0.024	0.024	0.023
6	0.024	0.022	0.023	0.024	0.022	0.023
7	0.023	0.022	0.024	0.025	0.023	0.020
8	0.024	0.023	0.023	0.024	0.022	0.021
9	0.023	0.023	0.024	0.025	0.023	0.022
10	0.024	0.023	0.024	0.025	0.024	0.024
Mean	0.023	0.023	0.024	0.025	0.023	0.022
Standard Deviation	0.0005	0.0008	0.0005	0.0005	0.0009	0.0012

TABLE XII

MODULUS OF RUPTURE (BAR) FOR TEN REPLICATIONS
OF EACH TREATMENT FOR COBB LOAMY SAND

Replication	Treatments (% Super Slurper)					
	0.0	0.025	0.05	0.1	0.2	0.4
1	0.452	0.386	0.409	0.292	0.146	0.115
2	0.491	0.432	0.405	0.301	0.155	0.109
3	0.408	0.325	0.402	0.295	0.181	0.116
4	0.484	0.391	0.403	0.294	0.167	0.097
5	0.485	0.390	0.313	0.249	0.173	0.094
6	0.414	0.397	0.322	0.303	0.185	0.118
7	0.419	0.375	0.372	0.263	0.198	0.117
8	0.411	0.391	0.392	0.251	0.198	0.123
9	0.433	0.409	0.346	0.291	0.166	0.108
10	0.416	0.392	0.379	0.265	0.195	0.120
Mean	0.441	0.389	0.374	0.280	0.176	0.112
Standard Deviation	0.034	0.027	0.036	0.021	0.018	0.010

TABLE XIII

BULK DENSITY (G/CC) OF THE BRIQUETS FOR TEN REPLICATIONS OF EACH TREATMENT FOR COBB LOAMY SAND

Replication	Treatments (% Super Slurper)					
	0.0	0.025	0.05	0.1	0.2	0.4
1	1.227	1.226	1.240	1.245	1.248	1.224
2	1.215	1.233	1.199	1.208	1.225	1.211
3	1.208	1.215	1.224	1.224	1.222	1.204
4	1.222	1.204	1.200	1.226	1.221	1.226
5	1.228	1.228	1.217	1.248	1.234	1.224
6	1.225	1.223	1.219	1.243	1.211	1.215
7	1.218	1.215	1.222	1.245	1.219	1.214
8	1.212	1.198	1.203	1.209	1.213	1.208
9	1.239	1.211	1.225	1.225	1.242	1.236
10	1.225	1.226	1.207	1.213	1.224	1.220
Mean	1.222	1.218	1.216	1.229	1.226	1.218
Standard Deviation	0.009	0.011	0.012	0.015	0.011	0.009

TABLE XIV

MOISTURE CONTENT (G/G) OF THE BRIQUETS FOR TEN REPLICATIONS OF EACH TREATMENT FOR COBB LOAMY SAND

Replication	Treatments (% Super Slurper)					
	0.0	0.025	0.05	0.1	0.2	0.4
1	0.005	0.005	0.005	0.005	0.005	0.005
2	0.005	0.005	0.005	0.004	0.005	0.005
3	0.005	0.005	0.005	0.005	0.005	0.005
4	0.005	0.005	0.005	0.004	0.005	0.005
5	0.005	0.005	0.004	0.005	0.005	0.005
6	0.006	0.005	0.005	0.005	0.005	0.005
7	0.005	0.005	0.005	0.004	0.005	0.006
8	0.005	0.005	0.005	0.005	0.005	0.005
9	0.005	0.005	0.005	0.004	0.005	0.005
10	0.005	0.005	0.005	0.004	0.005	0.005
Mean	0.005	0.005	0.005	0.004	0.005	0.005
Standard Deviation	0.0003	0.0	0.0003	0.0005	0.0	0.0003

APPENDIX B

EXPERIMENTAL DATA FOR WATER RETENTION

TABLE XV

WATER CONTENT (G/G) AT SELECTED SUCTIONS FOR ALL TREATMENTS FOR TELLER SANDY LOAM

Suction (Bars)	Replication	Treatments (% Super Slurper) 0.0	0.025	0.05	0.1	0.2	0.4
0.2	1	0.106	0.086	0.108	0.102	0.112	0.151
	2	0.099	0.087	0.095	0.103	0.118	0.137
	3	0.090	0.085	0.097	0.114	0.109	0.157
	4	0.105	0.087	0.103	0.109	0.123	0.148
	5	0.097	0.097	0.096	0.104	0.119	0.152
	6	0.097	0.095	0.092	0.096	0.104	0.141
	7	0.097	0.098	0.096	0.102	0.115	0.143
	8	0.101	0.095	0.090	0.101	0.121	0.143
	9	0.101	0.096	0.090	0.096	0.109	0.136
	10	0.099	0.098	0.097	0.107	0.105	0.149
Mean		0.099	0.092	0.096	0.103	0.113	0.146
Standard Deviation		$4.3X10^{-3}$	$5.1X10^{-3}$	$5.3X10^{-3}$	$5.3X10^{-3}$	$6.4X10^{-3}$	$6.5X10^{-3}$
0.5	1	0.069	0.068	0.068	0.068	0.080	0.083
	2	0.070	0.070	0.066	0.070	0.074	0.089
	3	0.068	0.067	0.065	0.067	0.076	0.093
	4	0.069	0.066	0.066	0.067	0.074	0.091
	5	0.067	0.067	0.062	0.065	0.075	0.090
	6	0.068	0.066	0.068	0.071	0.075	0.087
	7	0.066	0.066	0.067	0.069	0.077	0.094
	8	0.069	0.072	0.068	0.069	0.079	0.089
	9	0.067	0.066	0.070	0.069	0.081	0.086
	10	0.069	0.069	0.069	0.069	0.072	0.091
Mean		0.068	0.068	0.067	0.068	0.076	0.089
Standard Deviation		$1.2X10^{-3}$	$2.0X10^{-3}$	$2.2X10^{-3}$	$1.6X10^{-3}$	$2.8X10^{-3}$	$3.1X10^{-3}$

TABLE XV (Continued)

Suction (Bars)	Replication	Treatments (% Super Slurper) 0.0	0.025	0.05	0.1	0.2	0.4
1.0	1	0.055	0.054	0.054	0.056	0.065	0.074
	2	0.058	0.055	0.055	0.054	0.065	0.078
	3	0.055	0.057	0.054	0.055	0.062	0.071
	4	0.058	0.055	0.049	0.058	0.059	0.070
	5	0.058	0.055	0.047	0.059	0.060	0.079
	6	0.055	0.058	0.055	0.054	0.065	0.079
	7	0.061	0.054	0.054	0.052	0.065	0.075
	8	0.056	0.053	0.054	0.058	0.068	0.075
	9	0.054	0.059	0.052	0.054	0.063	0.071
	10	0.054	0.055	0.055	0.056	0.064	0.072
Mean		0.056	0.056	0.053	0.056	0.064	0.074
Standard Deviation		$2.3X10^{-3}$	$1.8X10^{-3}$	$2.6X10^{-3}$	$2.1X10^{-3}$	$2.5X10^{-3}$	$3.2X10^{-3}$
4.9	1	0.043	0.042	0.040	0.043	0.043	0.052
	2	0.045	0.040	0.039	0.042	0.043	0.047
	3	0.044	0.040	0.040	0.040	0.042	0.047
	4	0.043	0.042	0.042	0.041	0.042	0.044
	5	0.044	0.041	0.042	0.041	0.042	0.046
	6	0.045	0.041	0.044	0.041	0.048	0.046
	7	0.042	0.039	0.040	0.042	0.045	0.049
	8	0.044	0.042	0.042	0.040	0.045	0.050
	9	0.044	0.039	0.039	0.041	0.044	0.051
	10	0.042	0.041	0.041	0.042	0.044	0.046
Mean		0.043	0.041	0.041	0.041	0.044	0.048
Standard Deviation		$1.0X10^{-3}$	$1.1X10^{-3}$	$1.5X10^{-3}$	$0.9X10^{-3}$	$1.8X10^{-3}$	$2.4X10^{-3}$

TABLE XV (Continued)

Suction (Bars)	Repli- cation	Treatments (% Super Slurper) 0.0	0.025	0.05	0.1	0.2	0.4
9.8	1	0.037	0.036	0.035	0.035	0.040	0.041
	2	0.036	0.036	0.036	0.037	0.042	0.046
	3	0.037	0.037	0.036	0.034	0.041	0.043
	4	0.038	0.036	0.035	0.036	0.042	0.044
	5	0.035	0.035	0.035	0.038	0.043	0.043
	6	0.034	0.035	0.035	0.034	0.040	0.043
	7	0.035	0.033	0.036	0.036	0.041	0.042
	8	0.038	0.037	0.035	0.038	0.041	0.043
	9	0.038	0.038	0.036	0.037	0.040	0.042
	10	0.036	0.037	0.036	0.033	0.040	0.043
Mean		0.036	0.036	0.035	0.036	0.041	0.043
Standard Deviation		$1.4X10^{-3}$	$1.3X10^{-3}$	$0.5X10^{-3}$	$1.7X10^{-3}$	$1.0X10^{-3}$	$1.3X10^{-3}$
13.8	1	0.037	0.034	0.036	0.036	0.038	0.040
	2	0.035	0.035	0.033	0.040	0.038	0.040
	3	0.034	0.034	0.034	0.035	0.038	0.042
	4	0.037	0.035	0.035	0.037	0.035	0.041
	5	0.037	0.034	0.034	0.037	0.037	0.039
	6	0.037	0.036	0.035	0.034	0.040	0.042
	7	0.033	0.035	0.035	0.035	0.040	0.043
	8	0.035	0.037	0.034	0.036	0.037	0.043
	9	0.035	0.036	0.033	0.034	0.038	0.039
	10	0.036	0.034	0.034	0.033	0.037	0.042
Mean		0.035	0.035	0.034	0.036	0.038	0.041
Standard Deviation		$1.4X10^{-3}$	$1.0X10^{-3}$	$0.9X10^{-3}$	$1.9X10^{-3}$	$1.4X10^{-3}$	$1.4X10^{-3}$

TABLE XVI

WATER CONTENT (G/G) AT SELECTED SUCTIONS FOR ALL TREATMENTS FOR TILLMAN-HOLLISTER CLAY LOAM

Suction (Bars)	Replication	Treatments (% Super Slurper)					
		0.0	0.025	0.05	0.1	0.2	0.4
0.2	1	0.295	0.256	0.267	0.262	0.295	0.300
	2	0.290	0.282	0.263	0.265	0.290	0.287
	3	0.287	0.267	0.272	0.262	0.281	0.305
	4	0.296	0.251	0.275	0.277	0.279	0.306
	5	0.304	0.285	0.273	0.251	0.277	0.317
	6	0.270	0.297	0.291	0.286	0.316	0.299
	7	0.286	0.275	0.277	0.274	0.297	0.317
	8	0.295	0.274	0.277	0.280	0.288	0.302
	9	0.302	0.292	0.292	0.279	0.316	0.325
	10	0.298	0.267	0.264	0.261	0.290	0.317
Mean		0.292	0.275	0.275	0.270	0.293	0.307
Standard Deviation		$9.3X10^{-3}$	$1.4X10^{-2}$	$9.5X10^{-3}$	$1.1X10^{-2}$	$1.3X10^{-2}$	$1.1X10^{-2}$
0.5	1	0.203	0.193	0.197	0.190	0.193	0.198
	2	0.194	0.193	0.195	0.190	0.186	0.205
	3	0.194	0.195	0.202	0.188	0.205	0.209
	4	0.207	0.199	0.194	0.186	0.194	0.204
	5	0.201	0.188	0.196	0.198	0.189	0.198
	6	0.188	0.189	0.195	0.177	0.197	0.197
	7	0.200	0.188	0.176	0.176	0.197	0.210
	8	0.190	0.190	0.174	0.176	0.187	0.211
	9	0.182	0.189	0.185	0.175	0.197	0.200
	10	0.194	0.187	0.182	0.180	0.198	0.197
Mean		0.195	0.191	0.190	0.184	0.194	0.203
Standard Deviation		$7.2X10^{-3}$	$3.6X10^{-3}$	$9.1X10^{-3}$	$7.5X10^{-3}$	$5.5X10^{-3}$	$5.3X10^{-3}$

TABLE XVI (Continued)

Suction (Bars)	Repli- cation	Treatments (% Super Slurper)					
		0.0	0.025	0.05	0.1	0.2	0.4
1.0	1	0.173	0.164	0.148	0.143	0.164	0.174
	2	0.168	0.162	0.144	0.146	0.171	0.175
	3	0.159	0.166	0.146	0.145	0.161	0.171
	4	0.164	0.165	0.147	0.144	0.165	0.176
	5	0.169	0.155	0.136	0.147	0.162	0.172
	6	0.144	0.144	0.133	0.142	0.151	0.168
	7	0.153	0.147	0.133	0.142	0.156	0.169
	8	0.150	0.148	0.128	0.146	0.154	0.160
	9	0.148	0.142	0.126	0.133	0.152	0.157
	10	0.149	0.146	0.126	0.136	0.154	0.160
Mean		0.158	0.154	0.137	0.142	0.159	0.168
Standard Deviation		$9.7X10^{-3}$	$9.1X10^{-3}$	$8.4X10^{-3}$	$4.3X10^{-3}$	$6.5X10^{-3}$	$6.5X10^{-3}$
4.9	1	0.127	0.121	0.127	0.129	0.131	0.127
	2	0.126	0.121	0.121	0.130	0.126	0.136
	3	0.127	0.123	0.120	0.123	0.128	0.128
	4	0.126	0.127	0.118	0.134	0.123	0.126
	5	0.128	0.123	0.120	0.120	0.124	0.130
	6	0.123	0.122	0.126	0.123	0.126	0.132
	7	0.123	0.124	0.126	0.121	0.122	0.132
	8	0.130	0.121	0.124	0.122	0.132	0.133
	9	0.119	0.121	0.127	0.123	0.124	0.133
	10	0.126	0.121	0.125	0.125	0.124	0.137
Mean		0.125	0.123	0.123	0.125	0.126	0.131
Standard Deviation		$2.9X10^{-3}$	$1.9X10^{-3}$	$3.2X10^{-3}$	$4.3X10^{-3}$	$3.2X10^{-3}$	$3x5X10^{-3}$

TABLE XVI (Continued)

Suction (Bars)	Replication	Treatments (% Super Slurper)					
		0 0	0.025	0.05	0.1	0.2	0.4
9.8	1	0.106	0.107	0.106	0.107	0.108	0.113
	2	0.109	0.110	0.108	0.107	0.107	0.115
	3	0.108	0.110	0.110	0.107	0.108	0.115
	4	0.112	0.108	0.109	0.110	0.109	0.114
	5	0.108	0.112	0.111	0.110	0.108	0.112
	6	0.109	0.106	0.109	0.110	0.107	0.118
	7	0.109	0.105	0.112	0.111	0.109	0.118
	8	0.106	0.109	0.110	0.112	0.106	0.117
	9	0.108	0.106	0.111	0.109	0.108	0.115
	10	0.109	0.107	0.109	0.110	0.108	0.117
Mean		0.108	0.108	0.110	0.109	0.108	0.115
Standard Deviation		$1.6X10^{-3}$	$2.1X10^{-3}$	$1.6X10^{-3}$	$1.7X10^{-3}$	$0.87X10^{-3}$	$2.0X10^{-3}$
13.8	1	0.102	0.105	0.104	0.106	0.104	0.110
	2	0.102	0.104	0.106	0.099	0.106	0.112
	3	0.103	0.102	0.102	0.100	0.107	0.110
	4	0.103	0.101	0.102	0.101	0.102	0.111
	5	0.103	0.104	0.103	0.102	0.105	0.111
	6	0.096	0.100	0.102	0.106	0.107	0.111
	7	0.101	0.101	0.102	0.105	0.105	0.110
	8	0.102	0.100	0.103	0.104	0.105	0.109
	9	0.105	0.102	0.102	0.107	0.106	0.111
	10	0.100	0.103	0.103	0.107	0.104	0.108
Mean		0.102	0.102	0.103	0.104	0.105	0.111
Standard Deviation		$2.3X10^{-3}$	$1.7X10^{-3}$	$1.2X10^{-3}$	$2.8X10^{-3}$	$1.4X10^{-3}$	$1.1X10^{-3}$

TABLE XVII

WATER CONTENT (G/G) AT SELECTED SUCTIONS FOR ALL TREATMENTS FOR COBB LOAMY SAND

Suction (Bars)	Replication	Treatments (% Super Slurper)					
		0.0	0.025	0.05	0.1	0.2	0.4
0.2	1	0.045	0.052	0.051	0.050	0.074	0.154
	2	0.049	0.053	0.053	0.059	0.081	0.140
	3	0.049	0.058	0.050	0.056	0.074	0.159
	4	0.046	0.048	0.051	0.055	0.079	0.157
	5	0.049	0.050	0.054	0.060	0.083	0.136
	6	0.053	0.057	0.050	0.062	0.084	0.145
	7	0.048	0.056	0.050	0.054	0.075	0.144
	8	0.053	0.056	0.056	0.058	0.078	0.152
	9	0.054	0.054	0.052	0.054	0.075	0.148
	10	0.054	0.059	0.056	0.055	0.074	0.137
Mean		0.050	0.054	0.053	0.056	0.078	0.147
Standard Deviation		$3.1X10^{-3}$	$3.4X10^{-3}$	$2.2X10^{-3}$	$3.3X10^{-3}$	$3.7X10^{-3}$	$7.8X10^{-3}$
0.5	1	0.040	0.042	0.038	0.042	0.051	0.101
	2	0.042	0.040	0.039	0.043	0.050	0.097
	3	0.038	0.042	0.039	0.043	0.053	0.099
	4	0.040	0.041	0.039	0.043	0.060	0.112
	5	0.040	0.042	0.039	0.042	0.054	0.099
	6	0.044	0.044	0.039	0.041	0.057	0.103
	7	0.044	0.049	0.037	0.043	0.056	0.113
	8	0.043	0.044	0.039	0.048	0.058	0.104
	9	0.042	0.046	0.038	0.048	0.058	0.108
	10	0.045	0.043	0.037	0.044	0.055	0.101
Mean		0.042	0.043	0.038	0.044	0.055	0.104
Standard Deviation		$2.1X10^{-3}$	$2.5X10^{-3}$	$0.8X10^{-3}$	$2.3X10^{-3}$	$3.1X10^{-3}$	$5.3X10^{-3}$

TABLE XVII (Continued)

Suction (Bars)	Replication	Treatments (% Super Slurper) 0.0	0.025	0.05	0.1	0.2	0.4
1.0	1	0.030	0.029	0.030	0.029	0.042	0.095
	2	0.029	0.030	0.030	0.033	0.041	0.084
	3	0.029	0.032	0.029	0.031	0.043	0.089
	4	0.030	0.030	0.029	0.030	0.045	0.081
	5	0.029	0.030	0.029	0.028	0.042	0.082
	6	0.031	0.032	0.027	0.031	0.047	0.093
	7	0.033	0.034	0.028	0.032	0.046	0.091
	8	0.033	0.033	0.029	0.033	0.046	0.083
	9	0.033	0.034	0.028	0.031	0.048	0.083
	10	0.032	0.029	0.028	0.031	0.041	0.083
Mean		0.031	0.031	0.029	0.031	0.044	0.086
Standard Deviation		$1.6X10^{-3}$	$1.8X10^{-3}$	$0.9X10^{-3}$	$1.5X10^{-3}$	$2.5X10^{-3}$	$4.8X10^{-3}$
4.9	1	0.027	0.027	0.025	0.028	0.032	0.073
	2	0.026	0.027	0.025	0.027	0.034	0.072
	3	0.026	0.028	0.027	0.030	0.037	0.071
	4	0.026	0.027	0.026	0.028	0.033	0.071
	5	0.026	0.026	0.025	0.027	0.035	0.071
	6	0.025	0.026	0.027	0.027	0.038	0.068
	7	0.026	0.026	0.026	0.026	0.037	0.073
	8	0.026	0.025	0.027	0.028	0.034	0.071
	9	0.025	0.026	0.025	0.026	0.033	0.071
	10	0.025	0.027	0.027	0.027	0.035	0.069
Mean		0.026	0.026	0.026	0.028	0.035	0.071
Standard Deviation		$0.6X10^{-3}$	$0.8X10^{-3}$	$0.9X10^{-3}$	$1.1X10^{-3}$	$1.9X10^{-3}$	$1.5X10^{-3}$

TABLE XVII (Continued)

Suction (Bars)	Replication	Treatments (% Super Slurper)					
		0.0	0.025	0.05	0.1	0.2	0.4
9.8	1	0.022	0.025	0.025	0.025	0.030	0.053
	2	0.025	0.024	0.023	0.026	0.033	0.057
	3	0.023	0.025	0.025	0.025	0.035	0.063
	4	0.024	0.025	0.025	0.026	0.036	0.062
	5	0.025	0.024	0.024	0.026	0.030	0.057
	6	0.024	0.025	0.024	0.027	0.031	0.062
	7	0.025	0.024	0.026	0.026	0.032	0.056
	8	0.025	0.026	0.025	0.026	0.034	0.061
	9	0.025	0.025	0.024	0.026	0.032	0.064
	10	0.023	0.025	0.024	0.025	0.033	0.063
Mean		0.024	0.025	0.024	0.025	0.033	0.060
Standard Deviation		1.0×10^{-3}	0.6×10^{-3}	0.8×10^{-3}	0.6×10^{-3}	1.9×10^{-3}	3.5×10^{-3}
13.8	1	0.021	0.021	0.026	0.026	0.032	0.055
	2	0.021	0.023	0.024	0.025	0.033	0.058
	3	0.021	0.022	0.025	0.026	0.030	0.059
	4	0.022	0.023	0.023	0.027	0.032	0.057
	5	0.021	0.021	0.024	0.025	0.031	0.054
	6	0.022	0.022	0.024	0.025	0.030	0.054
	7	0.021	0.023	0.024	0.027	0.031	0.056
	8	0.021	0.022	0.025	0.026	0.031	0.057
	9	0.022	0.022	0.025	0.027	0.030	0.058
	10	0.021	0.022	0.024	0.025	0.031	0.055
Mean		0.022	0.022	0.024	0.026	0.031	0.056
Standard Deviation		0.5×10^{-3}	0.7×10^{-3}	0.8×10^{-3}	0.8×10^{-3}	0.9×10^{-3}	1.7×10^{-3}

APPENDIX C

EXPERIMENTAL DATA FOR WATER INFILTRATION RATE

TABLE XVIII

CUMULATIVE INFILTRATION (I) FOR DIFFERENT ELAPSED TIMES (T) FOR UNTREATED TELLER SANDY LOAM

Replications 1		2		3	
I (Cm.)	T (Min.)	I (Cm.)	T (Min.)	I (Cm.)	T (Min.)
1.15	1.28	1.28	1.63	1.09	0.92
1.80	2.80	1.80	3.23	2.24	4.88
2.31	4.98	2.44	5.28	3.53	12.35
2.95	7.97	3.08	9.00	4.68	22.50
3.59	12.82	3.59	12.60	5.83	35.18
4.10	16.82	4.23	16.80	7.12	49.35
4.74	22.08	4.87	22.08	8.27	65.05
5.39	28.90	5.52	29.15	9.55	81.78
6.03	36.00	6.03	33.62	10.71	108.05
6.54	42.25	6.67	42.25	11.99	137.02
7.18	51.57	7.18	49.00		
7.69	59.25	7.82	57.75		
8.33	67.27	8.46	67.23		
8.98	76.33	9.10	77.42		
9.62	86.48	9.62	88.37		
10.13	96.40	10.26	100.02		
10.77	110.25	10.77	108.17		
11.28	118.80	11.41	123.13		
11.92	132.25	12.05	139.18		
12.18	139.67	12.57	148.72		

TABLE XIX

CUMULATIVE INFILTRATION (I) FOR DIFFERENT ELAPSED TIMES (T) FOR TREATED (0.4% SUPER SLURPER) TELLER SANDY LOAM

Replications 1		2		3	
I (Cm.)	T (Min.)	I (Cm.)	T (Min.)	I (Cm.)	T (Min.)
1.03	2.92	1.03	2.62	1.03	2.25
1.67	7.56	1.67	6.92	1.67	6.22
2.18	13.10	2.18	12.32	2.18	10.25
2.82	21.16	2.82	18.75	2.82	16.82
3.45	31.92	3.46	29.27	3.46	27.92
3.98	41.09	3.98	39.06	3.98	39.59
4.62	55.20	4.62	51.41	4.62	53.50
5.26	70.90	5.26	66.26	5.26	68.88
5.90	94.48	5.90	84.64	5.90	83.72
6.41	113.00	6.41	99.00	6.41	99.34
7.05	133.40	7.05	118.16	7.05	116.99
7.57	154.01	7.57	136.19	7.57	134.89
8.21	177.42	8.21	161.80	8.21	158.76
8.85	200.22	8.85	186.32	8.85	182.30
9.50	228.31	9.50	216.68	9.50	213.25
10.00	253.45	10.00	240.25	10.00	234.06
10.64	283.25	10.64	273.90	10.64	259.18
11.16	306.95	11.16	296.87	11.16	285.64
11.80	342.62	11.80	329.06	11.92	331.28
12.31	364.43	12.18	346.33	12.44	351.64

TABLE XX

CUMULATIVE INFILTRATION (I) FOR DIFFERENT ELAPSED TIMES (T) FOR UNTREATED TILLMAN-HOLLISTER CLAY LOAM

Replications					
1		2		3	
I (Cm.)	T (Min.)	I (Cm.)	T (Min.)	I (Cm.)	T (Min.)
0.51	0.76	0.51	0.52	1.15	3.39
1.15	3.17	1.15	2.65	1.80	8.58
1.80	9.06	1.80	6.45	2.31	13.62
2.31	13.18	2.31	12.55	2.95	22.37
2.95	22.28	2.95	20.53	3.59	32.72
3.59	31.47	3.59	30.53	4.10	41.60
4.10	41.60	4.10	38.43	4.74	55.06
4.74	54.02	4.74	51.83	5.39	72.42
5.39	72.59	5.39	69.15	6.03	89.68
6.03	92.35	6.03	84.70	6.54	108.58
6.54	108.78	6.54	101.25	7.18	123.21
7.18	132.71	7.18	128.15	7.69	145.68
7.69	148.08	7.69	136.68	8.33	162.05
8.33	176.62	8.33	155.30	8.98	183.33
8.98	208.22	8.98	182.25	9.62	215.21
9.62	231.04	9.62	204.50	10.13	235.08
10.13	253.13	10.13	227.70	10.77	264.39
10.77	285.27	10.77	262.33	11.28	290.36
11.28	320.77	11.28	289.00	11.92	324.36
11.92	348.94	11.92	316.83	12.56	363.28
12.56	388.09	12.56	351.18	13.08	392.83
13.08	416.57	13.08	380.62	13.72	433.89
13.72	460.53	13.72	420.25	14.23	473.50
14.36	498.63	14.36	462.25	14.87	511.21
14.87	523.95	15.13	500.42		

TABLE XXI

CUMULATIVE INFILTRATION (I) FOR DIFFERENT ELAPSED TIMES (T) FOR TREATED (0.4% SUPER SLURPER) TILLMAN-HOLLISTER CLAY LOAM

Replication 1		Replication 2		Replication 3	
I (Cm.)	T (Min.)	I (Cm.)	T (Min.)	I (Cm.)	T (Min.)
0.51	0.69	0.51	1.00	0.51	1.10
1.15	4.04	1.15	5.24	1.15	5.38
1.80	10.69	1.80	10.96	1.80	11.63
2.31	17.31	2.31	17.64	2.31	16.24
2.95	27.56	2.95	30.25	2.95	27.35
3.59	42.64	3.59	43.69	3.59	42.90
4.10	58.52	4.10	56.55	4.10	55.20
4.74	76.21	4.74	74.82	4.74	71.40
5.39	100.20	5.39	96.83	5.39	92.74
6.03	121.66	6.03	126.34	6.03	116.86
6.54	149.57	6.54	146.41	6.54	135.26
7.18	182.52	7.18	175.56	7.18	167.18
7.70	211.70	7.70	201.92	7.70	188.24
8.33	247.12	8.33	235.32	8.33	219.93
8.98	289.68	8.98	278.22	8.98	259.85
9.62	317.55	9.62	306.25	9.62	293.44
10.13	342.25	10.13	338.56	10.13	324.72
10.77	380.25	10.77	373.65	10.77	368.64
11.28	420.66	11.28	404.41	11.28	401.20
11.92	464.40	11.92	446.05	11.92	437.23
12.56	512.12	12.56	494.17	12.56	473.06
13.08	557.43	13.08	524.87	13.72	562.64
13.72	601.23	13.72	575.04	14.36	601.72
14.36	650.76	14.36	630.51	15.13	659.46
14.87	683.82	15.13	678.60		

TABLE XXII

CUMULATIVE INFILTRATION (I) FOR DIFFERENT ELAPSED TIMES (T) FOR UNTREATED COBB LOAMY SAND

Replication 1		2		3	
I (Cm.)	T (Min.)	I (Cm.)	T (Min.)	I (Cm.)	T (Min.)
2.18	0.47	2.31	0.52	2.31	0.65
3.46	1.17	3.59	1.22	3.59	1.30
4.62	2.07	4.74	2.27	4.74	2.37
5.77	3.23	5.90	3.40	5.90	3.45
7.05	4.90	7.18	4.73	7.18	5.42
8.21	6.52	8.33	6.17	8.33	7.05
9.49	8.20	9.62	7.72	9.62	8.88
10.64	10.08	10.77	9.58	10.77	10.93
11.80	11.97	11.92	11.48	11.92	13.83
12.95	15.20	13.08	14.43	13.08	16.65
14.23	17.97	14.36	17.80	14.36	20.43
15.26	21.15	15.26	20.25	15.13	22.65

TABLE XXIII

CUMULATIVE INFILTRATION (I) FOR DIFFERENT ELAPSED TIMES (T) FOR TREATED (0.4% SUPER SLURPER) COBB LOAMY SAND

Replications					
1		2		3	
I (Cm.)	T (Min.)	I (Cm.)	T (Min.)	I (Cm.)	T (Min.)
2.31	0.73	2.31	0.78	2.31	0.58
3.59	1.75	3.59	1.63	2.95	0.96
4.74	2.88	4.74	2.82	3.59	1.49
5.90	4.83	5.90	4.48	4.10	1.96
7.18	6.35	7.18	6.38	4.74	2.62
8.33	8.55	8.33	8.65	5.39	3.72
9.62	11.15	9.62	11.18	6.03	4.33
10.77	13.68	10.77	14.03	6.54	5.02
11.92	17.30	11.92	17.18	7.18	6.35
13.08	20.42	13.08	20.50	7.69	7.08
14.36	24.40	14.36	24.05	8.33	8.29
15.00	26.82	14.87	30.27	8.98	9.61
				9.62	11.04
				10.13	12.46
				10.77	13.99
				11.28	15.37
				11.92	16.65
				12.56	18.49
				13.08	20.07
				13.72	22.09
				14.36	23.91
				15.13	26.21

APPENDIX D

CHEMICAL PROPERTIES OF THE SELECTED SOILS

TABLE XXVI

CHEMICAL PROPERTIES OF THE SELECTED SOILS

Property	Soils		
	Teller Sandy Loam	Tillman-Hollister Clay Loam	Cobb Loamy Sand
pH	7.8	7.8	7.5
Sodium (ppm)	5.55	98.0	9.85
Calcium (ppm)	8.82	127.9	44.77
Magnesium (ppm)	3.42	32.1	4.55
Total Soluble salts (ppm)	101	845	325
Sodium Adsorption Ratio	0.4	2.0	0.4
Exchangeable Sodium, %	0.0	1.65	0.0
Electrical Conductivity of 1-1 Extract (micromhos/cm)	153	1281	493

VITA

Parichehr Hemyari

Candidate for the Degree of

Master of Science

Thesis: EFFECT OF SUPER SLURPER (HYDROLIZED STARCH POLYACRYLONITRILE GRAFT COPOLYMER) ON SOIL CRUST STRENGTH, SOIL WATER RETENTION, AND SOIL WATER INFILTRATION RATE

Major Field: Agronomy

Biographical:

Personal Data: Born in Shiraz, Iran, December 31, 1954, the daughter of Mohamad Hadi Hemyari and Fatemeh Rahebi.

Education: Graduated from Mehrain High School at Shiraz in June, 1973; received Bachelor of Science degree in Soil Science from Pahlavi University in June, 1977; completed requirements for the Master of Science at Oklahoma State University in May, 1980.